MORE ABOUT THE "COMBINE" FIVE

MODERN WIRELESS

1/- MONTHLY

Edited by
NORMAN EDWARDS
M.I.R.E., M.R.S.L., F.R.G.S.

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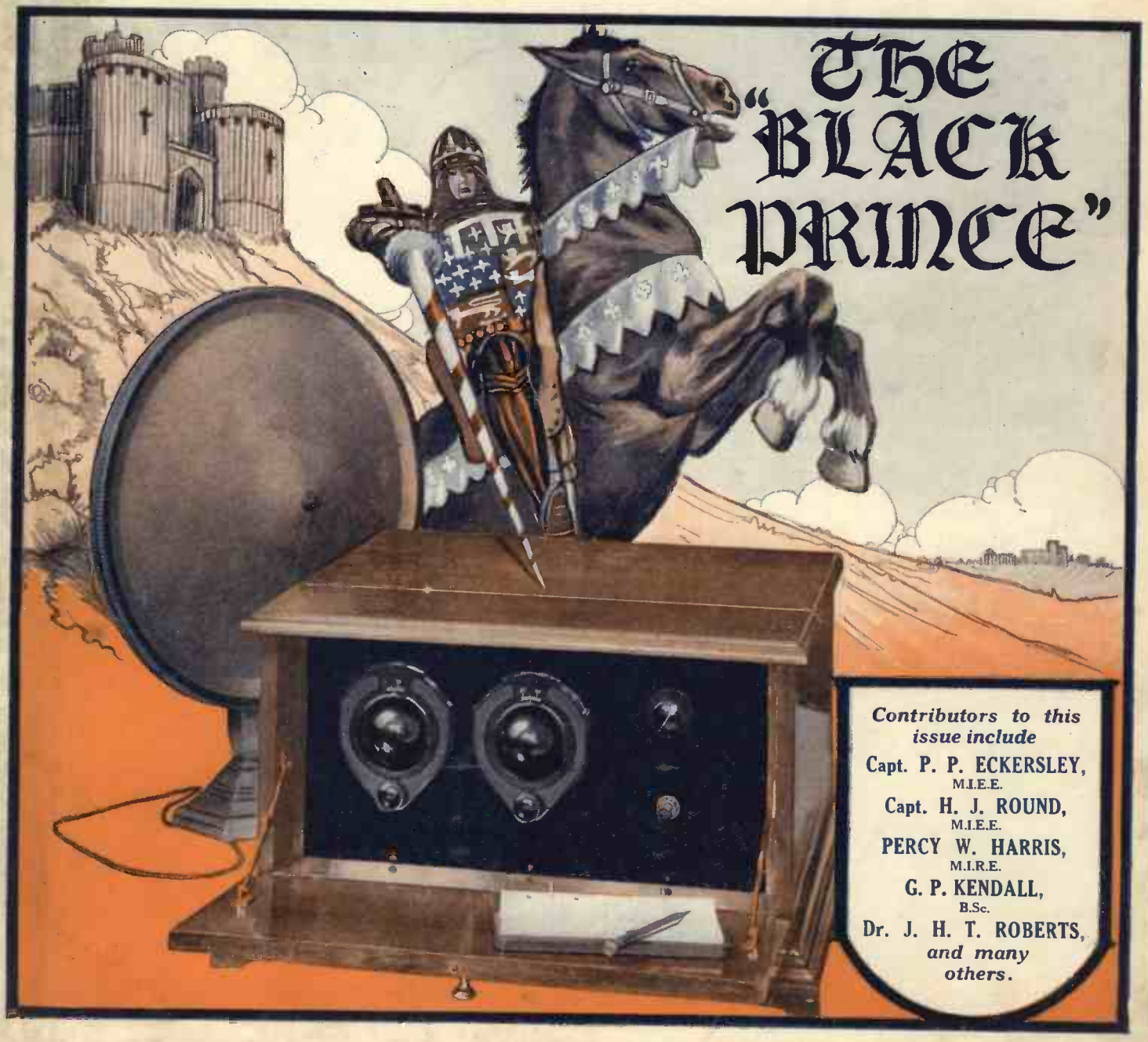

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Edited by NORMAN EDWARDS, M.I.R.E., M.R.S.L., F.R.G.S.

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The Search for Quality

HOW CAN THE QUALITY OF YOUR RECEPTION BE IMPROVED ?

In this article — the first of an important series — the Chief Engineer of the B.B.C. gives listeners some really practical details of set-design.

By Capt. P. P. ECKERSLEY, M.I.E.E.

THERE are signs that the public, stimulated by articles in the technical and lay Press, are beginning to pay more and more attention to the question of quality as opposed to quantity in broadcast reception. The writer has always believed that the permanency of broadcasting must rely upon an interest in listeners in what is received, not in the method of receiving it.

Anything that the B.B.C. may do in helping those who produce and use sets to make the best of their transmissions, they will do, and I feel I can do nothing better, in a series of articles, than to run through the underlying principles and try and set down in concise form some of the chief difficulties which prevent perfect reception.

The whole thing is so painfully simple in essence. The trouble is frequently that in steering between the Scylla of seeming to favour proprietary articles, and the Charybdis of vagueness, one is carried away from solid fact in a swirling spate of words which leave the reader lamenting our ever-increasing separation.

What is the Problem ?

Boldly to take the bull by the horns, it would be better to publish here and now the diagram of a set which satisfies not perhaps an ideal, but at any rate practical conditions. This I will do later, but in a series of technical articles, one must lead up to the final diagram, since it would seem a pity for people blindly to copy a specification knowing nothing about it. This so often does more harm than good.

In the first place, what exactly is the problem ? It is to design an apparatus which is first made to "pick up" wireless waves so that H.F. currents in time and tune with the transmitter flow in the aerial, next to "rectify" these currents so only the envelope of half the H.F. currents is thereafter dealt with, then to deal with this envelope of unidirectional impulses (called the low frequency) in a valve or chain of valves, so that eventually we have L.F. currents which are "shoved" into a "loud speaker" which very rarely reproduces what is "shoved" into it !

The H.F. System

First, then, we come to the question of the reception of the electric waves themselves. Certain cardinal principles here stand out.

Capt. P. P. Eckersley, the B.B.C.'s Chief Engineer and a staunch advocate of "Quality First."

(1) It is as well to have a sensitive aerial and aerial tuning system. Bad aerials mean oscillation and poor signals, or an expensive number of valves.

(2) It must be patent that the H.F. system, whatever it is, must not be so "efficient" as to be too selective. In broadcast telephony, we require to receive a fundamental frequency + 10,000 vibrations on either side. If the receiver is too selective the quality of the reception is affected.

(3) In spite of (2), we must have a respectable degree of selectivity, otherwise the set will fail to cut out one station in favour of another, if and when another is available.

What Some People Do

POINT 1.—On this question of general efficiency of an aerial, I simply say this : Many people, to save trouble, or, dare it be whispered ? sometimes to conceal the fact of their having a set, most often through ignorance, simply sling up a piece of wire round the room, use a coil of 44-wire, earth on to an aluminium-painted hot-water radiator, and either spend their time oscillating at about ten watts power or complain that the local station is weak.

It is a fact which I have seen demonstrated, that with a frame two feet square, or a small capacity aerial and low-resistance coils, a 3-valve set, not unduly forced, can be made to give fair strength at ten to fifteen miles from a main station.

It is a fact which is demonstrated too often to me in bitter experience, that many a 3-valve set with bad aerial, bad coil, and bad earth, but at the same time with a *big* aerial, has to be set on the verge of reaction ten to fifteen miles from London.

THE SEARCH FOR QUALITY—*concluded*

It is a fact that is demonstrated to me on a set that I am using, that even with an indifferent aerial and a not too good earth, a 4-valve set can be made to give, with as perfect quality as we know how to get (i.e. with *no* forcing), any foreign station worth hearing. The reason is that the design of coils is good.

I am getting at this. A good aerial, a good coil, and a good earth can be made to do wonders. It is no good expecting a small frame to do everything; it is no good expecting a good coil and a bad earth to be good; it is no good .... but I labour the point.

If you have room for it, put up a good, honest aerial, sixty feet horizontal, forty feet high, and lead it in to the set at once, not with bell wire run round the house. If you have difficulties in doing this, get as near to this ideal as you can.

Good Earth Essential

If you have facility, forget the gas main, the hot-water radiator, but do not be *so* shy of a good contact on to the water main. Best of all dig—and dig deep—in the garden, and buy a plate of copper or sheet metal, 5 ft. by 3 ft., and solder a good connection on to it, and make a real earth. If you cannot, the water main is good.

If all these ideas are out of the question, very often a good frame aerial is better than that deceiver of listeners, the "indoor aerial." One cannot be dogmatic, however, because conditions vary so much.

. . . Reaction, that wonderful but abused quality, should be used sparingly . . .

As to the aerial tuning inductance itself, I am always so surprised to find that so very few people realise that ohms mean resistance, and that resistance mean less current and less current mean weaker signals, and weaker signals mean more valves, and more valves mean more money. The average plug-in coil has a

"What is wrong, after all, with a circular former?" asks Capt. Eckersley in discussing the aerial coil to give best results.

resistance of 10, 20, 30, or some 60 ohms. Especially is this so on the long waves, where the aerial system may be as much as 200 ohms. The sort of value required is 20 or 30 at maximum for long waves and 5 or 10 on short.

What is wrong, after all, with a circular former? A cylinder, in fact, wound with wire. Here is a specification of a coil which is a wireless engineer's job. Diameter about 3 or 4 inches, length 3 or 4 inches and 15 to 20 turns to the inch. This for waves between 200 and 600 metres, but anyone can calculate it right; I give the general idea for guidance. The inductance of a cylindrical coil is given by $(\pi DN)^2 lk$, where D is the diameter, N the number of turns per unit length, l the length, and k is a constant which is given in tables in any good wireless text book. L comes out in centimetres. L can be calculated by the wave-length required, because the wave-length equals $2\pi\sqrt{CL}$, where C is the capacity. The point I am getting at is that these large coils of cylindrical form give a resistance of 1-10th or so of the compact type, and with a good aerial and earth, enormously increase the efficiency of the aerial system.

The Side-Band Problem

POINT 2.—In the medium waves, and for getting the local station where a lot of reaction should not be used, there should be very little fear of cutting off side bands. I have, however, noticed that the use of low damped coils probably does cut off a little "top," or, possibly, what comes to the same to the ear, enhances the bottom. This is not bad, because with top goes some "mush," and the effect is so gentle over the musical scale that, really, it is extremely pleasant. For long waves (Daventry), too excessive a reliance upon low damping may produce cut-off, so one would advise keeping the same sort of size of cylindrical coils, and winding with a much greater number of turns per unit length. The wave-length is about 4 times, hence the inductance has to be 16 times, but the number of this per unit length only 4 times. This will increase the damping sufficiently to avoid side band cut-off. Damping can be introduced, remember, by adding resistance—a very easy thing to do; efficiency cannot, with given coils, be increased by removing resistance!

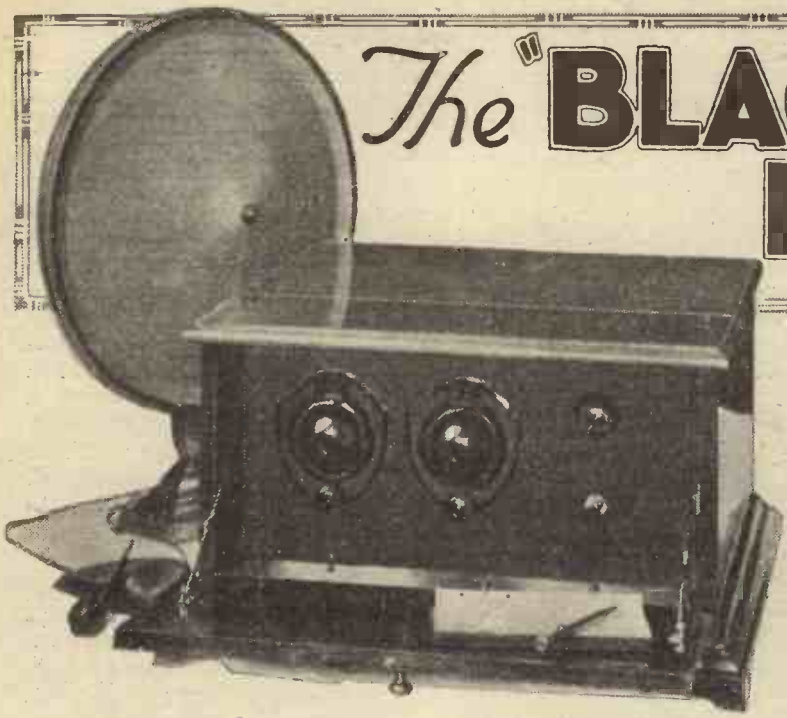
Alternative Programmes

As to POINT 3, quite a respectable start towards reasonable selectivity can be got by attending to coils. It is the intention of the Broadcasting Corporation, provided Government

Besides being very easily inserted or withdrawn the plug-in coil has the important advantage of compactness.

permission is given, to give alternative programmes in this country, by erecting twin wave-length stations in various parts of the country. This will mean that any set will have to have just that measure of selectivity to enable it to pick up art transmissions of equal *power*. This is very different from picking up a 1 kw. station at 200 miles while one is located a mile away from another station of 1 kw. The local station is then relatively overpowering. We are only asking for equality selection.

As to reaction, that wonderful but abused quality, the user should use it sparingly on medium waves; it is a snare and a delusion on the long. But H.F. efficiency makes its use controllable.



The "BLACK PRINCE"

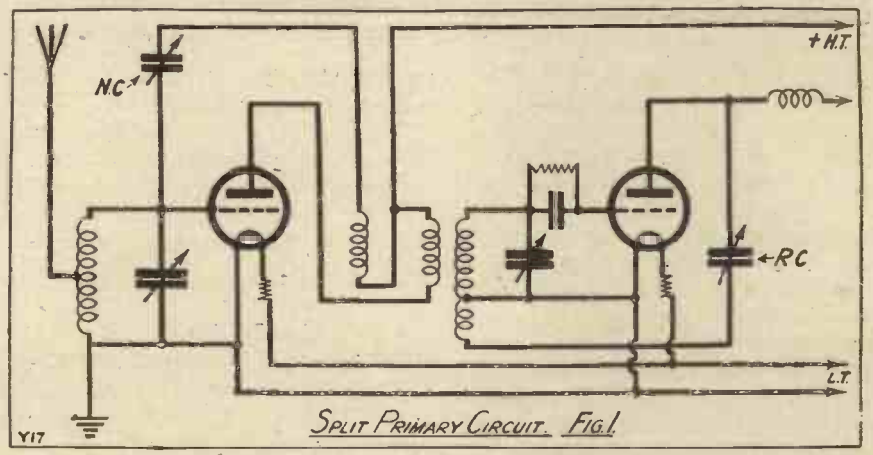
This unique four-valver embodies a solution to one of the outstanding problems that arise in connection with effective neutralisation. Mr. Harris in his usual practical manner has devised a method of applying the system, so that even inexpert constructors should now be able to get first class results without the slightest trouble. Moreover, the "Black Prince" will take practically any valves, and although it is a remarkably sensitive set and will bring in many stations on the speaker, it is very stable and very easy to handle. We confidently anticipate that the "Black Prince" will prove one of 1927's most popular four-valve receivers.

The set designed, built and described by
PERCY W. HARRIS, M.I.R.E.
(Editor of "The Wireless Constructor.")

THE great popularity achieved by what are generally termed "neutrodyne circuits" (although strictly speaking, this term should only be applied to those circuits devised by Prof. Hazeltine) has been due to the efficiency of the stabilising methods employed. This stability is secured, not by the old scheme of whittling down the energy available until the feed-back is insufficient to maintain oscillation, but by "balancing out" the feed-back current which would otherwise be a source of trouble.

Two Popular Arrangements

Two circuits which have achieved great popularity are shown in Fig. 1 (known as the "split primary" circuit) and in Fig. 2 (generally called "split-secondary.") For simplicity only one stage of H.F. magnification preceding the detector is shown, but



SPLIT PRIMARY CIRCUIT. FIG. 1.

COMPONENTS REQUIRED

1 ebonite panel, 16 × 8 × $\frac{3}{16}$ or $\frac{1}{4}$ in. (See notes.)
1 cabinet to take above, with baseboard 16 × 14 in. (See notes.)
1 pair brackets (Cameo, Magnum, Peto-Scott, etc.).
2 variable condensers, ·0003 mfd. (Bowyer Lowe, Popular).
1 variable condenser ·0005 mfd. (Bowyer Lowe, Popular).
2 Kurz-Kasch vernier part dials (Rothermel Radio Corpn.).
1 $1\frac{1}{2}$ in. arrow knob (Rothermel Radio Corpn.).
1 on and off switch (Decko).
2 standard screened coil screens and bases.
1 split secondary coil, lower range.
1 split secondary coil, Daventry range.
1 split primary coil, lower range.
1 split primary coil, Daventry range.
1 neutrovernier condenser (Gambrell).
1 balancing condenser (McMichael).
1 100,000 ohm anode resistance and base (Dubilier, Mullard, Varley, etc.).
2 250,000 ohm anode resistances and bases (Dubilier, Mullard, Varley, etc.).
4 fixed resistors (Amperites, Tenyrites, Magnum, etc.).
4 anti-vibratory valve holders (any good standard make; those shown are "Wearite")
1 ·0003 mfd. grid condenser and clips for series leak (S/P pattern T.C.B.).
4 grid leaks (Dubilier, Lissen, Mullard, etc.). See notes.
3 grid leak holders. (Dumetohm).
1 H.F. choke (McMichael, Varley, split-coil type, R.I., etc.).
3 fixed condensers ·015 mfd. (Dubilier type 610 or 620).
2 fixed condensers 1 mfd. (Dubilier, Lissen, T.C.C.).
1 terminal strip (Magnum).
Glazite or similar wire for wiring up.

Cost of set with cabinet, as illustrated, and coils for both ranges, but without valves £17.

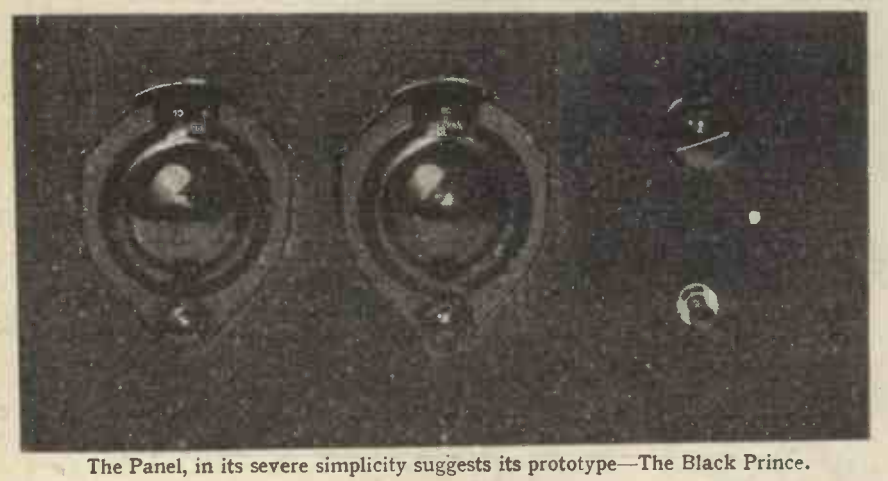
If $\frac{1}{4}$ in. panel is used, recesses most be cut at back to take nuts of K.K. dials, as these are designed for $\frac{3}{16}$ in. panels. Any standard "double depth" cabinet can be used. The handsome drop front cabinet illustrated was supplied by Peto-Scott Co., Ltd. Similar cabinets can be obtained from all the leading makers.

Values of leaks are discussed in article.

THE "BLACK PRINCE"—*continued*

the following remarks apply equally to one or more stages.

In the Fig. 1 circuit the small condenser NC is adjusted to balance out the reaction effect due to the capacity between the plate and the grid of the first valve. The primary winding of the H.F. transformer between the first and second valves, is divided; one half being connected between the plate and H.T. positive, and the other half between the H.T. positive and the neutralising condenser. Reaction in the detector circuit is obtained by the combination of capacitative and inductive reaction, with which the name of John L. Reinartz is generally associated.



The Panel, in its severe simplicity suggests its prototype—The Black Prince.

In the Fig. 2 circuit we have two identical H.F. transformers, the first being used to couple the aerial to the first grid circuit, and the second for coupling the plate circuit of the H.F. valve to the grid circuit of the detector. The secondary winding of each transformer is tapped in the centre, this point being taken through a high resistance to the valve filament. One end of the secondary of the radio frequency transformer is connected to the plate of the valve and the other to the grid, a variable condenser for tuning purposes, being connected across the whole coil. In this circuit, too, condenser NC is adjusted to balance out the effect of the capacity between the plate and the grid of the valve.

Parasitic Oscillation

Split coil circuits of this type have an unfortunate tendency to oscillate "on their own" at a frequency dependent upon the natural frequency of the secondary of the transformer, due to the fact that half of the coil, in the grid circuit, is tightly coupled to the other half in the plate circuit, giving the necessary coupling to maintain self-oscillation. Unless means are adopted to counteract this effect, it will be found impossible to stabilise the set over the whole range.

By inserting a fixed resistance of say 100,000 ohms. between the centre tap and the filament, these parasitic oscillations can be damped out without appreciably altering the efficiency at ordinary broadcast wave-lengths. A resistance between the centre tap and the filament of the detector is not necessary, as this circuit is sufficiently damped.

Good Circuits

Both of these circuits work quite well when suitably made up and adjusted, but every experimenter with such circuits is aware of the fact that the value of the capacity required to neutralise the circuits in Fig. 1 and Fig. 2 is often considerably in excess of the capacity of the valve itself (*i.e.*, that between grid and plate). Carelessness in making up a receiver may add a number of additional capacities needing to be neutralised, but frequently in the most carefully designed receiver the capacity needed is surprisingly large.

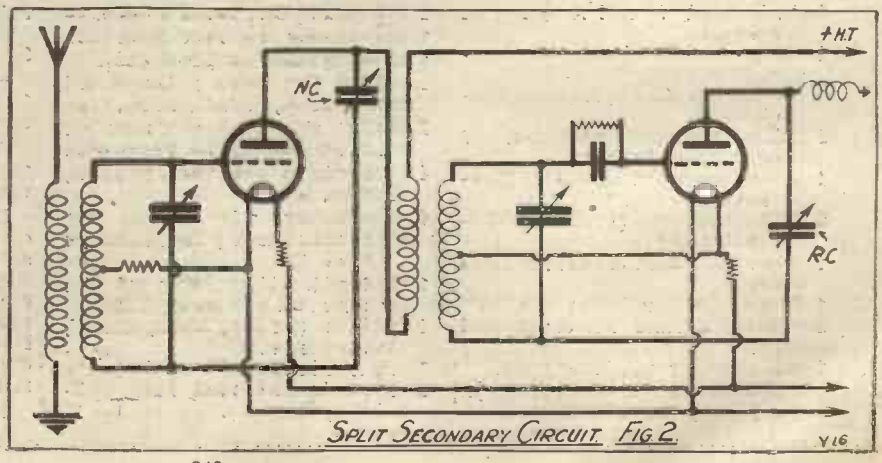
So far as the Fig. 1 circuit is concerned, it is doubtful whether it is a genuine neutralised circuit, although it gives a good measure of stability, but the Fig. 2 circuit (for which we have to thank the Weston Electric Co. of America) is much more of a true-"balanced" circuit.

Third Circuit Tried

There is no question that when the highest efficiency is required, reaction in the detector circuit is very valuable. The grid leak and condenser method of rectification introduces so much damping that the tuning in this circuit is flattened to a very great degree. By reaction, we can reduce the damping and therefore increase the signals to a considerable extent before reaching that point where distortion takes place.

The two popular ways of making up the set with one stage of neutralised H.F. and a regenerative detector, are those shown in Figs 1 and 2. Fig. 1, as I have indicated, is scarcely a real "balance" circuit. In Fig. 2 the reaction method, using a large condenser R C instead of a small neutralising condenser, possesses certain disadvantages which I have not space to mention here.

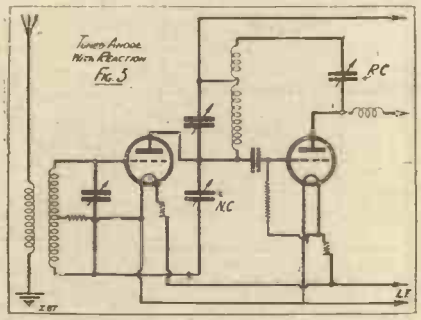
Fig. 3 shows a circuit made up with standard screen coils, which I recently assembled in the hope of obtaining the very distinct advantages of the tuned anode system with a regenera-



SPLIT SECONDARY CIRCUIT. FIG 2.

THE "BLACK PRINCE"—*continued*

tive detector. At first glance it looks very promising and should work well with any valve (which is certainly not the case with screen coil H.F. transformers) and has certain virtues of simplicity. The receiver was thereupon built up and a great deal of experimental data obtained. It was abandoned, however, as when the



circuit was properly neutralised, it was practically impossible with standard windings to obtain proper reaction effects, while tuning in the tuned anode circuit was exceedingly flat. On cutting out the H.F. valve without upsetting the neutralised state (this could be done by removing the fixed resistor) reaction in the detector circuit became perfectly normal over the whole range of the condenser, thus proving that the first circuit was introducing damping. I should say, in passing, that elaborate precautions were taken to see that the set was genuinely neutralised and a slight turn one way or the other of the neutralising condenser removed the neutralised condition.

The Final Arrangement

Fig. 4 shows this circuit re-drawn in a simplified form, from which it will be seen that the plate-filament resistance of the H.F. valve is shunted right across the grid circuit of the second valve, thus introducing considerable damping. Such a circuit can give quite good results with magnetic reaction of the swinging coil type, as a suitable coil can be introduced to give a tight reaction coupling.

Finally, after much experiment, the circuit shown in Fig. 5 was chosen and has given exceptionally good results, distinctly better than any other arrangement I have tried with the standard screen coil-windings. It is an admirable circuit for the six-pin transformers, whether used screened or unscreened. Where space permits it is decidedly better to use these coils without the screens, for shielding effect with the close screens of these is only obtained by an appreciable sacrifice of efficiency. To give the necessary spacing, however, in a four-valve receiver such as we are discussing here, the set would be unduly bulky, and furthermore as only one stage of H.F. is used and a regenerative detector, the loss introduced by the screen is not too noticeable.

Additional Capacity

Directly this circuit was fitted up and tested, several interesting points emerged. The first was that the amount of capacity necessary to neutralise the circuit was far smaller than usual, and in fact it was obviously in the neighbourhood of the capacity of the valve itself. To make this point clearer I may say with quite a number of valves in general use the minimum setting of a very low minimum neutralising condenser was too great, and it became necessary to connect a second neutralising condenser *between the plate and the grid* so as to bring the capacity of the valve, plus that of the additional condenser, within the range of the neutralising condenser.

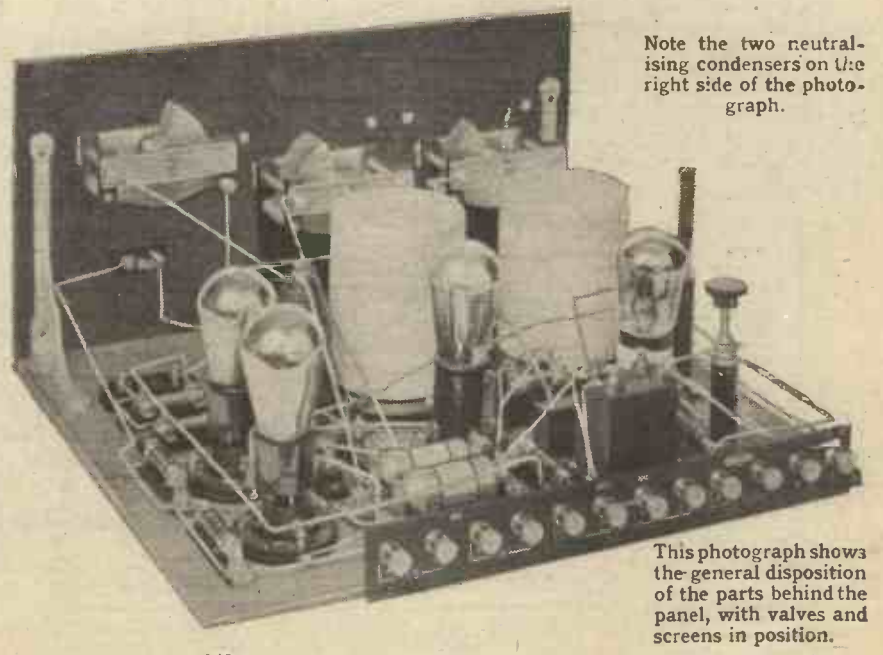
This arrangement, I may say, has certain distinct advantages and makes the accurate balancing of the receiver an easier task. There are also other less obvious but certainly definite advantages.

The second interesting point was that the circuit seemed to work very well indeed with a very wide variety of valves—an advantage which has been sought in the design of the "Black Prince." Many of the disappointing results readers have obtained with screened coils have been due to the use of unsuitable valves, as these transformers may require valves which the average user does not possess.

Tuning proved to be exceedingly sharp, and on changing from the short to the long range of wave-length, no readjustment of the neutralising condensers was found necessary. Reaction control was perfectly smooth and neutralising could be so definitely effected that when London was tuned in at full strength on a good aerial seven miles from the station, (the volume being considerably greater than is required for normal use) the removal of the fixed resistor in the first valve gave complete silence and London could not even be heard when one listened as close as possible to the loud speaker disc or horn.

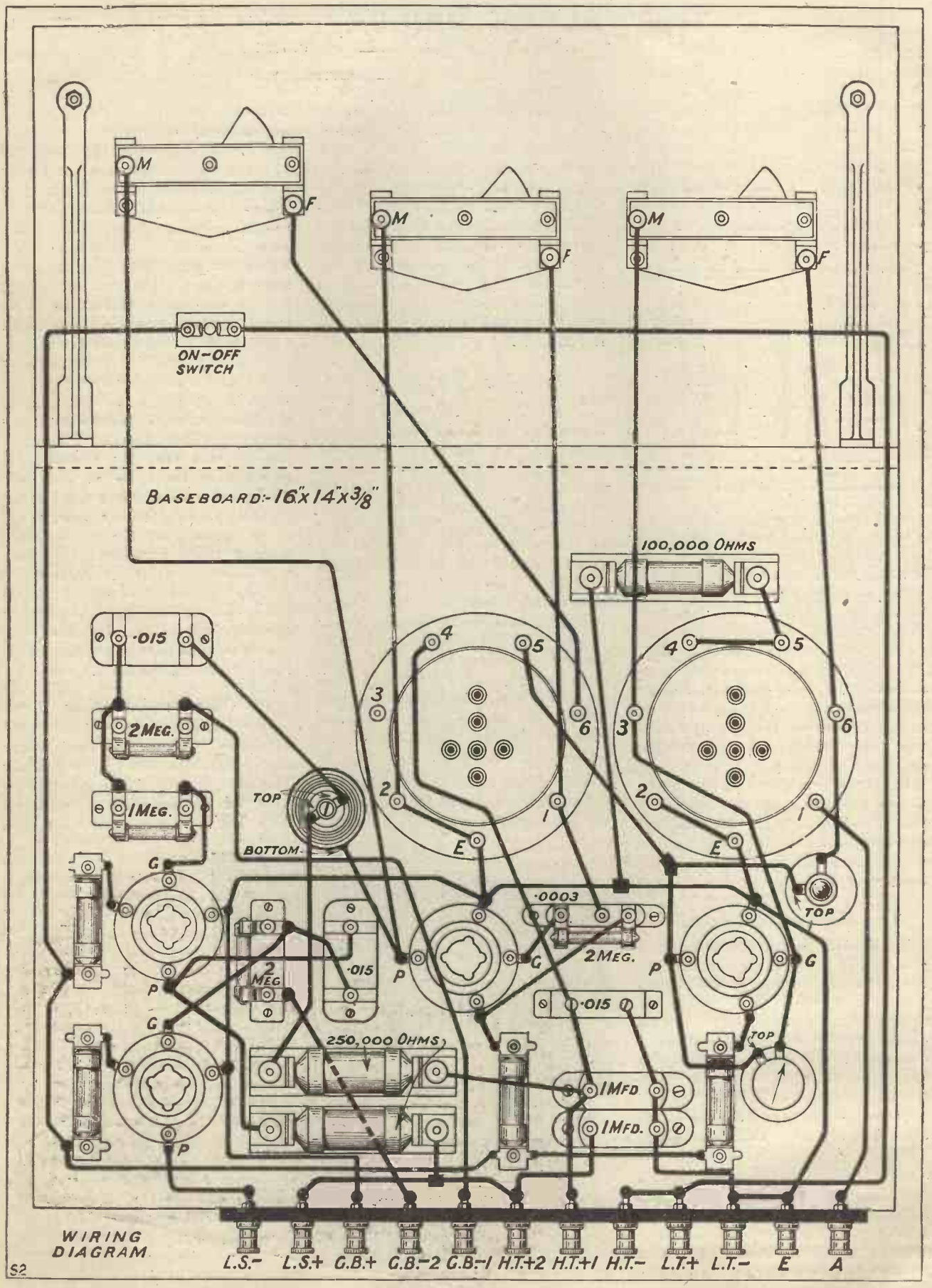
The Tuning Dials

One disadvantage of the split secondary circuit has been very successfully overcome in the "Black Prince" by the adoption of a particular type of vernier—the Kurz-Kasch Part Dial. If you examine a split



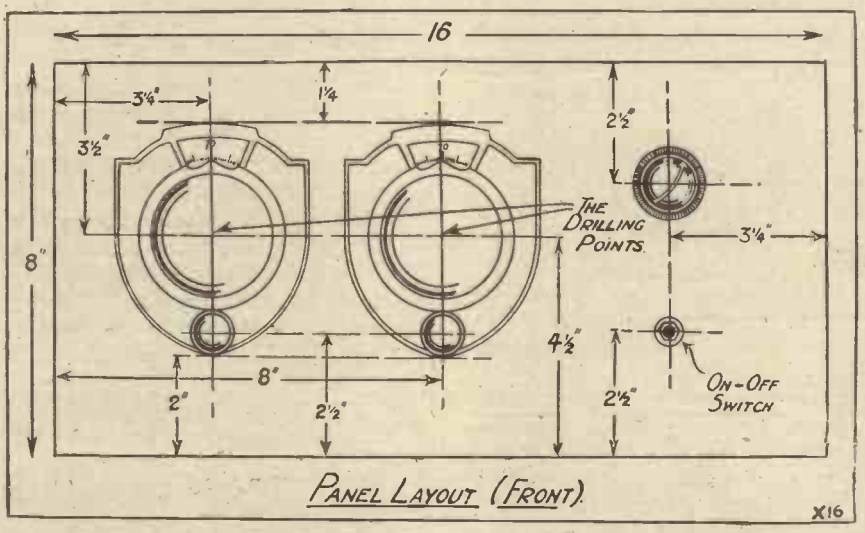
Note the two neutralising condensers on the right side of the photograph.

This photograph shows the general disposition of the parts behind the panel, with valves and screens in position.


M
F
ON-OFF SWITCH
BASEBOARD:-16"x14"x3/8"
100,000 OHMS
·015
2 MEG.
1 MEG.
TOP
BOTTOM
G
P
·0003
250,000 OHMS
1 MFD.
1 MFD.
WIRING DIAGRAM
L.S.- L.S.+ G.B.+ G.B.-2 G.B.-1 H.T.+2 H.T.+1 H.T.- L.T.+ L.T.- E A

THE "BLACK PRINCE"—*continued*

secondary circuit carefully you will see that neither the moving nor fixed plates of the condenser are at earth potential and for this reason the presence of the hand near either will affect sharp tuning. Practically all the vernier dials now sold have a metal plate connected to the shaft of the condenser, the vernier wheel bearing against the edge of this metal disc to give the necessary reduction gearing. It will be seen that by using the ordinary type of vernier dial with a split secondary circuit such as this, hand capacity effects may be very marked. The Kurz-Kasch dial is made entirely of Bakelite, the disc carrying the dial markings being of the same material. The principle of operation of these dials is similar to that of most others, a small wheel controlled by a hand-operated knob bearing against the edge of a large disc. As, however, this disc is of insulating material the hand need not come within an inch or two of the condenser plates, particularly if the type of condenser used in this set is adopted.



PANEL LAYOUT (FRONT).
X16

H.F. Damping Resistance

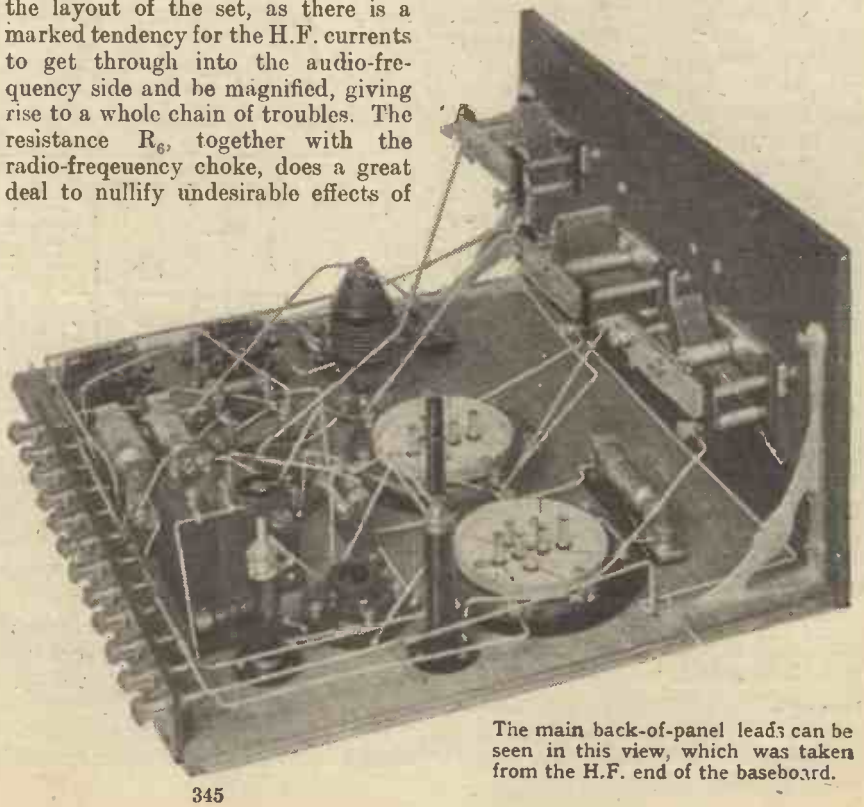
While the detector circuit is so arranged that the moving plates of the condenser are at earth potential, a second Kurz-Kasch dial is adopted for uniformity.

Fig. 6 shows the complete circuit diagram of the four-valve receiver, from which it will be seen that the audio frequency stages are resistance-coupled, the value of these resistances being high so as to utilise the new high magnification valves which give, with resistance coupling, a volume comparable with that given by a really good transformer.

On a closer examination of the circuit you will find the condenser NC_2, to which I referred earlier in the article, its use being to add to the capacity between plate and grid, and will note the resistance R_3, between the coupling condensers C_5 and the grid of the first note magnifying valve. When the new high magnification L.F. valves are used, more than usual care is necessary in the layout of the set, as there is a marked tendency for the H.F. currents to get through into the audio-frequency side and be magnified, giving rise to a whole chain of troubles. The resistance R_6, together with the radio-freqeuency choke, does a great deal to nullify undesirable effects of this kind. As a point of interest, it may be stated that while no unwanted effects were found on the ordinary broadcast band, when this resistance was omitted, its presence proved essential to obtain good quality when listening on the long wave-length range. Its value is best found by experiment, but can well be one megohm, the leak R_2 being, say, two megohms. If, in spite of this resistance undesirable effects are still found, due to a passage of H.F. current into the audio-frequency side, a condenser of ·002 mfd. across the loud speaker terminals will probably effect a complete cure.

Concerning the Coils

The figures in circles refer to the numbers on the screened coil bases. Any of the standard screened coils can be used. It may be wondered why a value of ·0003 mfd. has been chosen for the first variable condenser and ·0005 mfd. for the second. The reason will be plain when we consider that the split secondary coils were designed for tuning with a double ·0005 mfd condenser (giving an effective tuning capacity of ·00025), while the split primary type were designed to tune with a ·0005 mfd. condenser of the single variety. By using ·0003



The main back-of-panel leads can be seen in this view, which was taken from the H.F. end of the baseboard.

THE "BLACK PRINCE"—*continued*

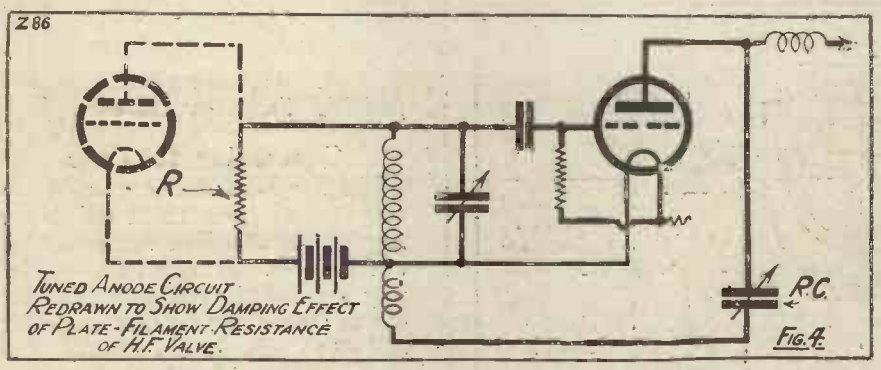
mfd. to tune the first coil, we make sure of covering the tuning range desired, while the ·0005 mfd. is, of course, the capacity necessary for the second, or the split primary, coil.

Special Features

A further advantage of using the split primary type of H.F. transformer as shown, without its neutralising winding, is that if we so desire we can still further tighten the coupling between the first and second valves, by using the neutralising winding as an additional winding in the primary. To do this it is only necessary to remove the H.T. positive connection from terminal 4 and place it on terminal 3. For this reason and those previously given, it will be seen that the present arrangement of the "Black Prince" is the most flexible so far published for use with the standard screened coil windings.

Other features of the circuit will be obvious on examination. It will be noted that there are but two H.T. positive terminals, the H.F. valve and the detector being joined to one and the two-note magnifying valves to the other. Due to the presence of the resistance in the anode circuit in the detector valve, the actual voltage applied to this valve is lower than that applied to the H.F. valve, which is as it should be. It should be remembered that with a modern neutralised circuit a much higher anode voltage can be used than was the case in the old days of potentiometer control. As a matter of fact, but for the question of economy of H.T. consumption, I should have made all valves work on an H.T. voltage of 120, for this is a desirable voltage to use with a resistance amplifier, and particularly with the new super-power valves for the last stage, while it is not really unduly high for the H.F. valve, or for the detector, taking into account the resistance in the circuit of the latter. However, a voltage of say, 80, on the H.F. valve is quite enough to give excellent results, while the drain on the H.T. battery is obviously less than it would be if a 120 were used throughout.

Although three variable condensers are used, it is quite unnecessary to use three vernier dials or indeed to use the conventional tuning dial on the reaction condenser. Tuning is effected on the two first condensers, which are, as stated, fitted with vernier dials, a small knob being used for the reaction control. Any knob of convenient size and good appearance can be used here.



TUNED ANODE CIRCUIT REDRAWN TO SHOW DAMPING EFFECT OF PLATE-FILAMENT RESISTANCE OF H.F. VALVE. FIG. 4.

Easy to Construct

The constructional work is quite simple and can be easily carried out from the wiring diagram. The layout of parts given should be closely followed, this being of the utmost importance on the H.F. side.

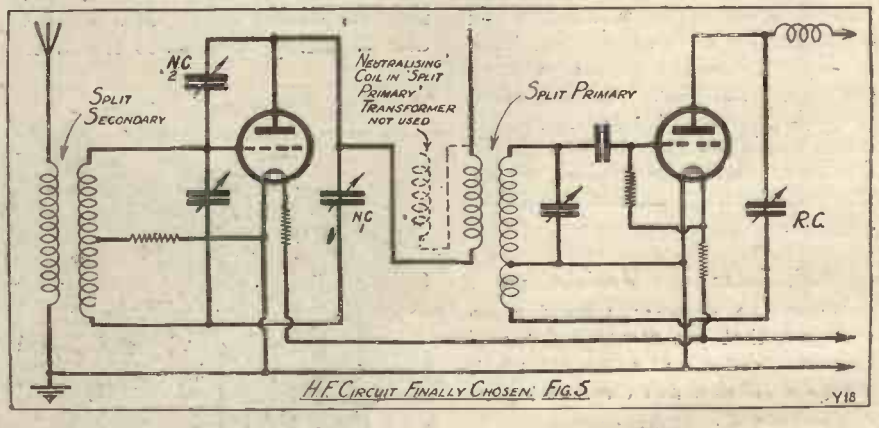
The following points require a word or two of explanation as they are not apparent from an examination of the diagrams and photographs.

Neutralising condensers of the progressively increasing capacity type are recommended, in preference to those in which two flat plates are brought closer together by means of a screwed rod. In the latter type of condenser, the capacity change is relatively small through most of the travel, but increases very rapidly towards the end. Furthermore, some of these condensers short circuit, which is dangerous in a receiver of this kind. A good combination of neutralising condensers for this receiver is the Gambrell "neutrovernia" for the actual neutralisation and the McMichael for the additional capacity across grid and plate of the H.F. valve. Baseboard mounting neutralising condensers consisting of interleaving plates can also be recommended for this second position.

By-Pass Condensers

The condenser of ·015 mfd. connected between the terminal 4 of the second screened coil and L.T. negative in the theoretical diagram, and actually connected across C_7 in the practical wiring diagram, is a radio frequency by-pass, the Mansbridge type of condenser being less efficient than the mica type for this purpose. The Mansbridge in parallel with this is a steadying condenser for the H.T. supply rather than a shunting condenser. The Mansbridge condenser C_8 serves both as a shunt and a steadying condenser for the H.T. supply.

Notice the fixed resistors used throughout this receiver. It is desirable that the cartridge type such as the Amperite be used in the



H.F. CIRCUIT FINALLY CHOSEN. FIG. 5. Y18

THE "BLACK PRINCE"—*continued*

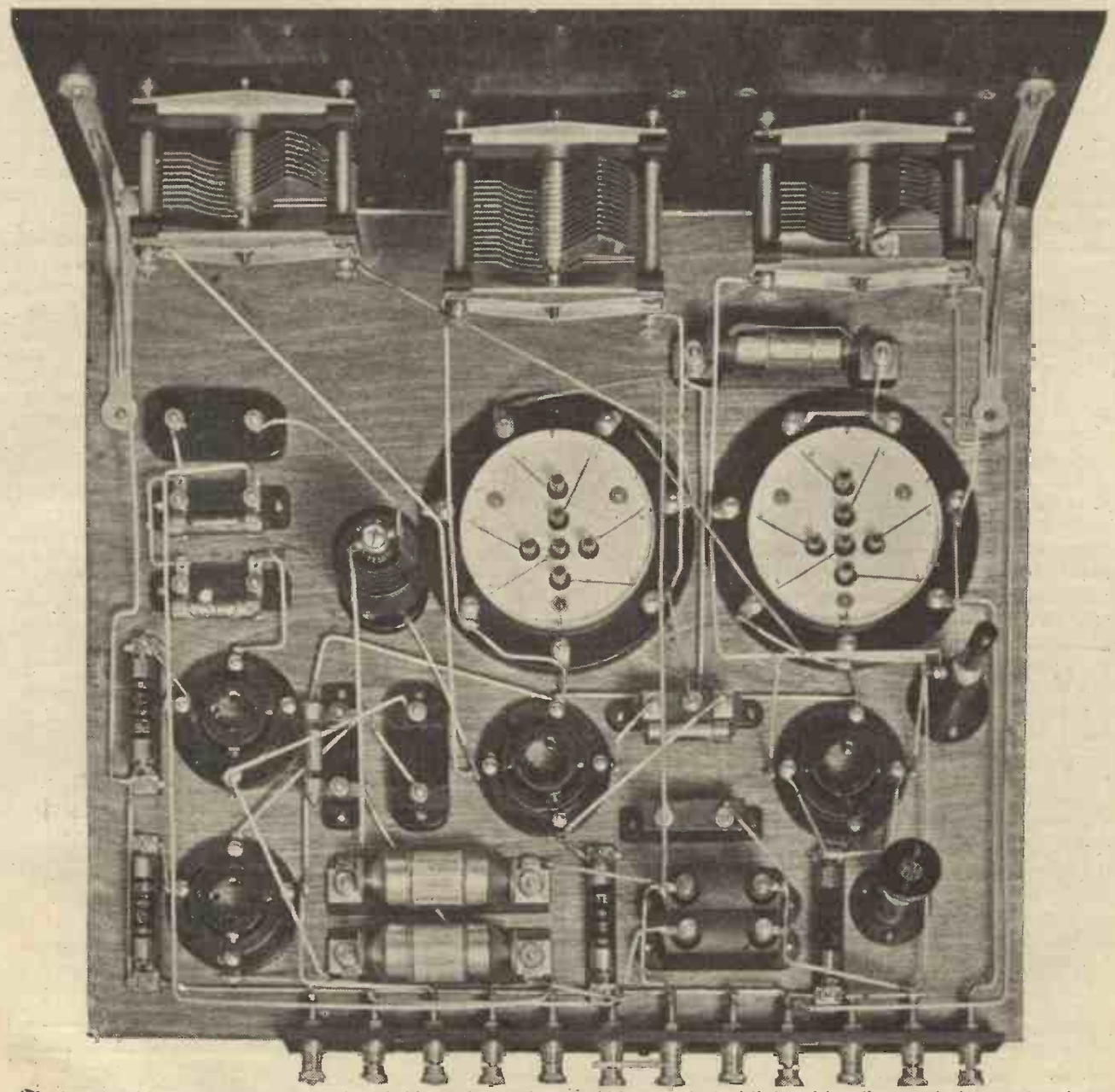
H.F. stage as its quick removal is an easy matter when neutralising. Furthermore, this type of filament control takes a very small space on the baseboard and facilitates wiring.

The appearance of a panel for a radio receiver such as this is greatly enhanced if it presents a uniform surface without screw heads showing. I have found a very simple method of improving the appearance of such panels, as follows:

After drilling holes to take screws which normally would show on the front of the panel (metal screws to hold the brackets, screw securing the ebonite panel to the baseboard, screws to hold variable condensers, etc.) countersink them deeper than usual so that the heads of the screws will be below the level of the panel.

Final Considerations

Procure from any stationer a box of "Glitter-wax" (the price is 6d., and the wax is used for children's modelling). You will find several coloured sticks, including a black and a red. Place the panel horizontally, after all components have been mounted, and with a lighted match melt some of the black wax so that it drops in and fills up the recesses where the screw heads show. See that plenty of wax drops into the holes and do not worry about the surplus. As soon as the wax is set, which will be only a minute or two, take a sharp knife and slice off the surplus wax. It will cut off very easily and cleanly, and then if you take a cloth or a piece of wash-leather and rub the panel it will polish easily and, indeed, the slight waxy film will help you in getting a good polish. The method is so simple that it can be



The baseboard layout is clearly shown by this illustration, which should be consulted with the wiring diagram during construction.

THE "BLACK PRINCE"—*continued*

carried out almost as quickly as it can be described. When using a mahogany finished panel, it is an easy matter to blend the red and the black wax to tone exactly with the portion of the panel to be filled up.

Suitable Valves

When the receiver has been wired up and is ready for test, you will need to choose your valves. The H.F. can be of the two- four- or six-volt type, designed for H.F. work. The detector is best chosen from one of the same type of valves, *i.e.*, those designed for H.F. work or the new high magnification resistance capacity valves. The first note magnifying valve should be one of the new valves designed for resistance-capacity amplification, and the last valve can be either an ordinary note magnifying valve of the small power type, or, best of all, one of the new super-power valves. This receiver will work very successfully with two, four and six-volt valves throughout, although best results are given with the six-volt. For the first note magnifying valve I have obtained excellent results with the new high-magnification resistance-capacity valves made by Cossor, Mullard and S.T., Ltd. For the super-power valve, the Cossor, Mullard and S.T. all work admirably. In the H.F. stages all of the leading makes have been tried and found successful.

If you are near a station, the set is very easily neutralised as follows. Set the reaction condenser at zero, place a little capacity between plate and grid of condenser NC_2, set the neutralising condenser about half-way down, and tune in the local station as loud as possible. With the settings mentioned on the two neutralising condensers, the set will probably be fairly stable. Make sure that the local station is tuned in accurately, and then remove the fixed resistor of the first valve, being careful in so doing not to upset any other adjustment. Listen carefully and you will probably hear the local station in the loud speaker, although at a very diminished strength. Now carefully turn the knob of the neutralising condenser, and the strength of the local station will either increase or diminish as you turn one way or the other. Adjust this condenser until you hear nothing of the local station or, if you are very close, only the slightest trace. You will find by turning the condenser that you will pass through a very quiet zone and indeed, in nearly every case, through a silent point. If you cannot find this point, readjust NC_2 and try again. It is best to adjust NC_2 until the neutralising position is about half-way through the travel of the neutralising condenser NC_1.

AN HOUR WITH THE "BLACK PRINCE."

(All stations on loud speaker.)

SHORT WAVE	1st Cond.	2nd Cond.
Munster	7	10
Malmo	10	13
Dublin	19	23
London	27	33
Spanish	30	34
Radio Toulouse	34	40
Spanish	35	41
Hamburg	36	42
Glasgow	38	45
Frankfort	43	51
Rome	48	58
Langenberg	53	63
Bournemouth	59	71
Brussels	64	76
Rosenhugel	67	81
German	72	85
Sundsvall	74	92
LONG WAVE.		
Daventry	38	50
Radio Paris	50	73

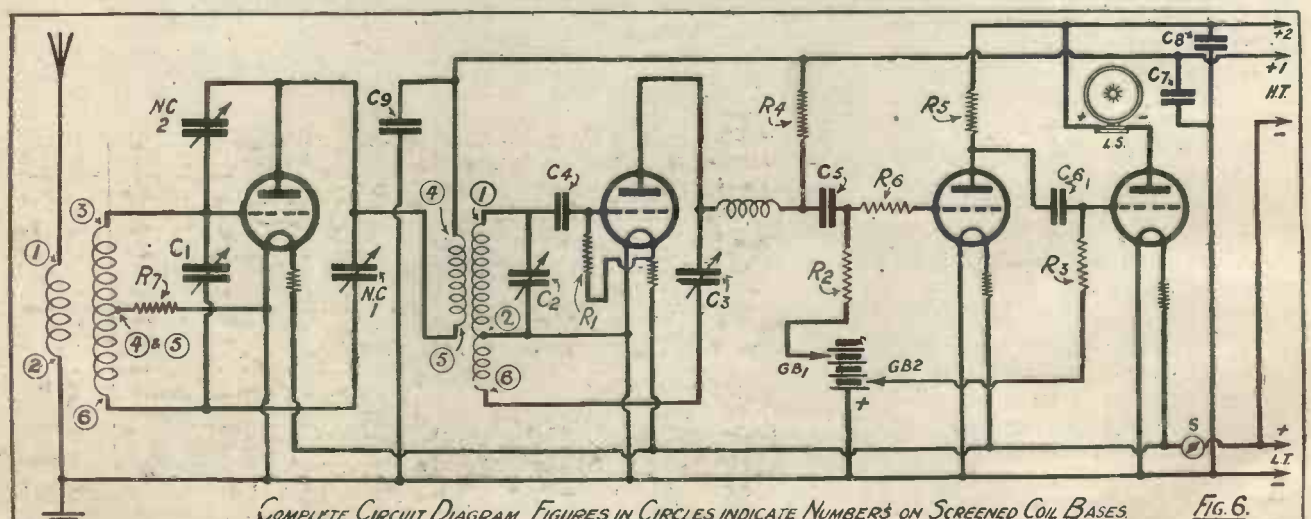
NOTE.—During the test different valves were tried. This slightly alters condenser readings, as does a varying degree of reaction. Subsequently a number of other stations were heard and identified.

Wave-length range on shorter band. 200 to 600 metres approximately, using Lewcos screened coils. Other makes give approximately same range, but different readings.

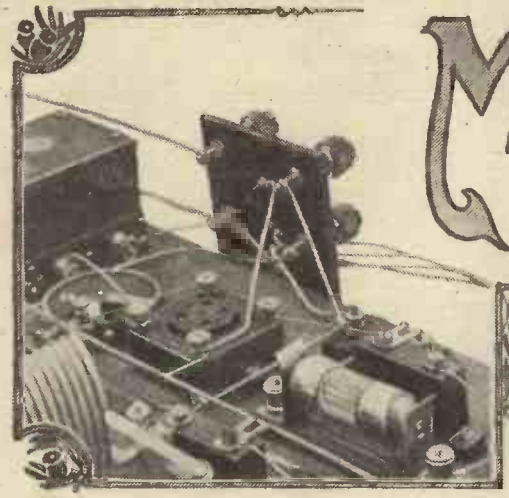
Another Neutralising Method

If you are a considerable distance from a broadcasting station, and cannot adopt the method just outlined, set the reaction condenser at zero, and the neutralising condenser at the minimum position and adjust condenser C_2 (the right-hand dial looking to the front of the panel) to a fairly low reading, say 40 degrees. Now turn the first dial and you will probably come to a point where the set will burst into oscillation. Carry on your adjustments past this until oscillation stops again. Having found the middle point in this oscillating band, carefully adjust the neutralising condenser NC_1 until the set will not oscillate at any setting of the dials. As before, try and adjust the two

(*Continued on page* 438.)



COMPLETE CIRCUIT DIAGRAM FIGURES IN CIRCLES INDICATE NUMBERS ON SCREENED COIL BASES. FIG. 6.



MY WIRELESS HERESIES

A provocative article, in which the writer questions the wisdom of some of the accepted tenets of set-design.

By R. W. HALLOWS, M.A.

SOMETIMES I am tempted to wonder whether certain of the conventions which we accept without a murmur should really be taken for granted. Both in the construction and in the operation of receiving sets there are quite a number of things that we do simply because everybody else does them, and not because we have ever bothered to reason them out. Some of these things are perfectly sound, but I am going to be bold enough to question the desirability of others.

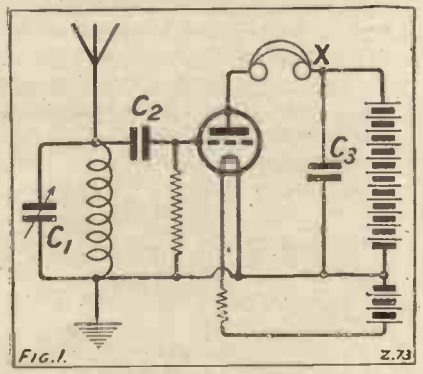


FIG. 1. Z.73

Take first of all the question of the way in which the high and low tension batteries are connected in the receiving set. In the majority of sets to-day the two batteries are placed in series, H.T. negative being connected to L.T. positive.

Doubtful Advantage

So far as I can see this method has only one advantage, though it has numerous drawbacks. The advantage is that by connecting up in this way the plate potential is that of the filament battery added to that of the H.T. battery. That is to say that at the best of times the extra plate voltage is only six; in many sets the amount is four or even two volts since very large numbers of people nowadays use one or two-cell accumulators for heating the filaments of dull-emitter valves.

Now the modern valve, with its high vacuum, is not in the least finicky about its plate potential; in fact, except in the case of a few special rectifying arrangements, an increase or decrease of 10 volts in the plate potential will generally make very little difference to results. An extra six volts is therefore of no great importance, and as for an additional *two*. . . ! The disadvantage of this sys- is that every earthed part of the set is in direct electrical connection with the negative pole of the single battery formed by connecting the two in series. This means that the risk of a valve-destroying short-circuit is greatly increased.

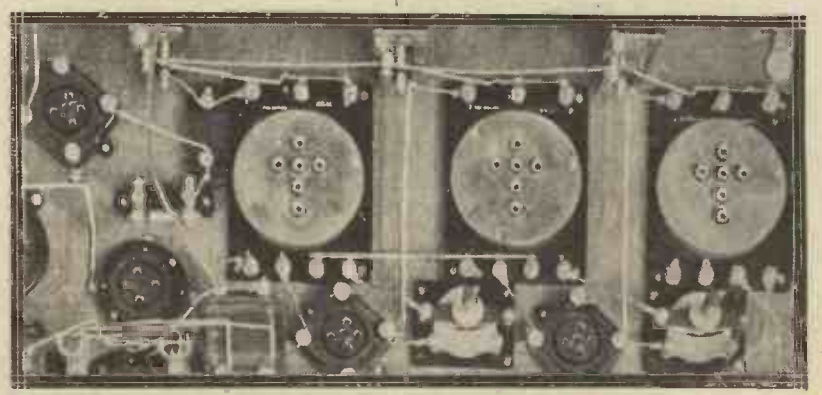
In sets employing any kind of screening on the H.F. side there are large uninsulated metal surfaces which are earthed; in any case it is common practice to earth the cores or the shields of L.F. transformers, and not infrequently earthed screening plates are used in conjunction with variable condensers, in order to minimise hand-capacity effects. Let a H.T.+ lead come into contact even for a moment with any of these things and the odds are that the filaments will be burnt out.

Now suppose that we arrange the batteries negative to negative. We lose admittedly two, four or six volts of plate potential, as the case may be, but this is more than offset by very considerable gains. A short-circuit now between H.T.+ and any earthed point is unlikely to injure the valves though its harmful effects upon the H.T. battery still, of course, remain.

The only danger point for a short so far as the valves are concerned is now to L.T.+. Few parts of the set are connected to L.T.+; the positive filament terminals of the valve-holders and possibly the rheostats or fixed resistors, if these are placed in the positive leads. The risk of an expensive short-circuit is, therefore, greatly reduced.

Better Stability?

Again, the negative terminals of both batteries are now earthed. It may be only my fancy, but it seems to me that in certain ultra-sensitive circuits this produces a greater measure of stability than is obtained by connecting one battery only directly to earth.



Short circuits are easily caused if the metal screening accidentally comes into contact with the wiring.

MY WIRELESS HERESIES—*continued*

In the early days of valve sets the two batteries were always connected negative to negative. It was usual in those days to connect the grid leak of the rectifying valve to L.T.— and the idea of placing the batteries in series does not seem to have come in until valves were designed to rectify with the grid leak taken to L.T.+. When series connection of batteries first became fashionable an absurd survival of one particular convention was seen for a long time—it still, in fact, appears to-day. This is illustrated in Figs. 1 and 2. One of the most important functions of the condenser placed across the H.T. battery is to provide a path to earth for oscillating impulses which allows them to avoid the resistance of the battery. In the circuit seen in Fig. 1 this condenser, C_3, is correctly placed between the point X and earth. For some reason or other the "reservoir" function of the condenser shunting the H.T. battery was at one time regarded as of paramount importance.

The "Reservoir" Effect

It used to be held that when a battery had become noisy a large condenser placed across it was capable of producing silent working by, so to speak, "mopping up" the inequalities in its output. This condenser undoubtedly has a certain quieting effect, though my experience is that even capacities of the order of 4 microfarads or more will not suffice to produce anything like a silent background if the battery is inclined to noisiness. The most important of the H.T. battery condenser's duties, that of providing a path to earth,

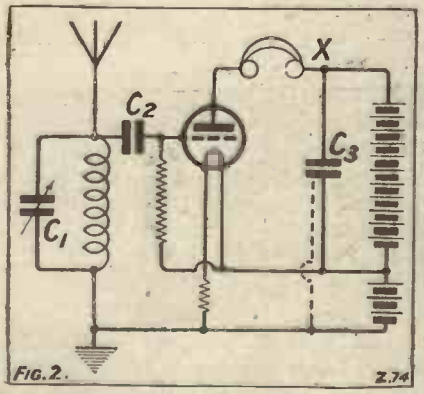
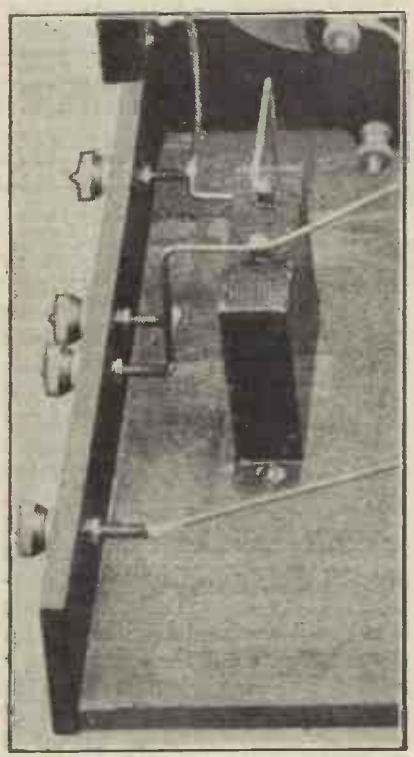


FIG. 2. Z.74

was lost sight of, and the condenser was connected, when the batteries were joined in series, as shown in Fig. 2. It is quite clear that the proper connection is that shown in dotted lines. This does not impair the reservoir action, such as it is, of the condenser, and it does provide a direct path to earth from the point X.


A fixed condenser wired across the H.T. battery was at one time regarded as of paramount importance.

Does it matter whether you use a high-resistance or a low-resistance loud speaker? Probably nine people out of ten will tell you that your results will be very much the same in either case, the great advantage of the low resistance instrument being that owing to the use of a transformer the steady plate current of the last valve does not pass through its windings and its great drawback being the very fact that such a transformer is required. It is quite true that it did not matter when there were no such things as power valves or super power valves. Reception was in any case so far from perfect (and transmission, too, for that matter) in those days that there was really no reason to bother about fine points.

It is impossible in the present short article to go into the theory or the mathematics of the loud speaker problem; all that one can say is that if an instrument with a resistance of some 2,000 ohms is placed directly in the plate circuit of a super-power valve with an impedance of 3,500 ohms or so, two very important and highly undesirable results follow. In the first place, the voltage drop across the loud speaker windings is far too great, and cuts down unduly the plate potential of the last valve Secondly, there is a very definite loss in quality. Such a loud speaker cannot bring out the low notes because its impedance is unsuited to that of the valve.

Output Transformer Best

For reception of really good quality it is advisable with either a power valve or a super-power valve to use a properly designed output transformer. Its primary impedance must fit in with that of the valve and the secondary must contain such a number of turns that a proper amount of current is delivered to the windings of the loud speaker.

Quite apart from these considerations it is, to say the least of it, looking for trouble to use a high-resistance instrument in a circuit where the steady current passing through the windings may amount to 10 or 15 milliamperes

Are we right in insisting that the aerial should always be as high as can be managed? From one point of view we undoubtedly are, since the high aerial, other things being equal, means in ninety-nine cases out of a hundred greater range and greater signal strength than the low. But it must not be forgotten that a lofty outdoor wire is prone to bring in unwanted impulses as well as those that are desired.

Aerials Too High

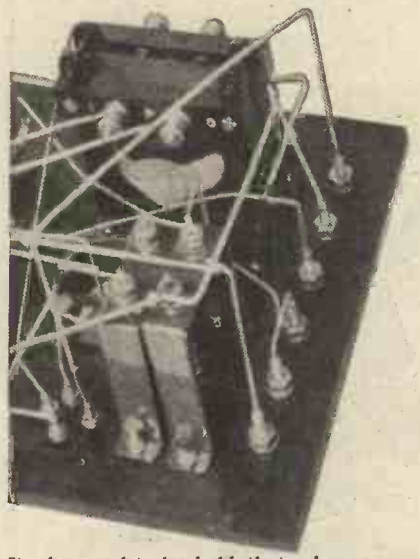
Since the adoption of the Geneva wave-length scheme the greatest source of interference on the broadcast band has been spark signals. A spark signal consists of a train of heavily damped waves whose tendency is to set an aerial oscillating at its fundamental frequency. Atmospherics, again, are caused by wave-trains of much the same kind; they are also heavily damped, though frequently they are not symmetrical. The higher the aerial the more liable it is to bring in interference from both sources. For broadcast reception purposes an aerial height of 30 ft. is possibly as much as is ever required,

MY WIRELESS HERESIES—*concluded*

and the writer has found by experience that it often pays to work with something less than this.

Lowering the aerial means, it is true, a slight reduction in signal strength, but few people mind making this sacrifice when it means also a reduction in spark and atmospheric strength. Where interference from spark stations is very bad one may go even further by doing away altogether with the outdoor wire and using instead an indoor aerial made by stretching a length of No. 18 D.C.C. round three sides of a room.

I have seen it stated frequently that if you wish to obtain reception of real quality you should cast out



It also used to be held that a large condenser connected across the H.T. was capable of silencing a noisy H.T. battery.

the grid leak and condenser from the circuits of your rectifying valve and adopt the anode bend system. This is sound advice—up to a point. The anode bend rectifier is actually not quite above suspicion even when most carefully designed. It *can*, and often does, produce much worse distortion than that due to grid leak rectification. Though the grid leak rectifier is shown by an oscillograph to cause distortion, I rather doubt whether the human ear can detect the very small deformations of wave forms that result from its use, provided that the L.F. amplifiers are beyond suspicion.

This leads me to yet another heretical view. Innumerable authorities have stated that those who wish to rid themselves once and for all of distortion on the L.F. side of the set will eschew transformers and chokes and pin their faith to resistance-capacity coupling. This form of coupling is, in fact, held up as being the panacea for all note-magnifying ills.

Resistance Coupling

Well, I have had a little experience of resistance-capacity coupled note-magnifiers, and all that I can say is that the business of obtaining with their help a respectable volume of undistorted sound, is by no means as simple or as straightforward as some would have us believe. Just put a milliammeter into the plate circuit of the last valve, and see if the needle is perfectly steady. It ought to be if two of the commonest causes of distortion—"grid-currenting and "bottom-bending" are absent. Are they really absent? Just try the milliammeter and see.

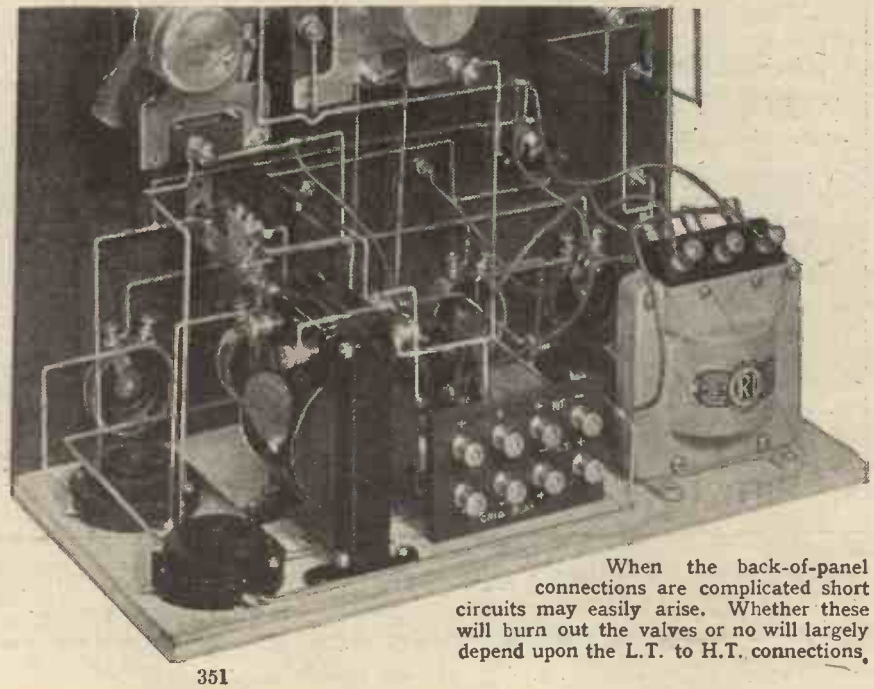
One last heresy, which will give every reader an opportunity of flinging an epistolary brick at my devoted head. Nearly everybody nowadays is enthusiastic about the neutrodyne circuit, and speaks scornfully of the old tuned anode which (*a*) "was inherently unstable"; (*b*) "had to be held down to earth by the application of a strong positive potential," which meant (*c*) "the introduction of heavy damping," and (*d*) "enormous losses in point of selectiveness and signal strength." I wonder!

My own belief is that the "inherent instability" of the tuned anode was due mainly to interaction between its inductance and the A.T.I. or some other tuned H.F. coil. Anyhow, I do know that by careful design you could produce tuned anode sets which were perfectly stable.

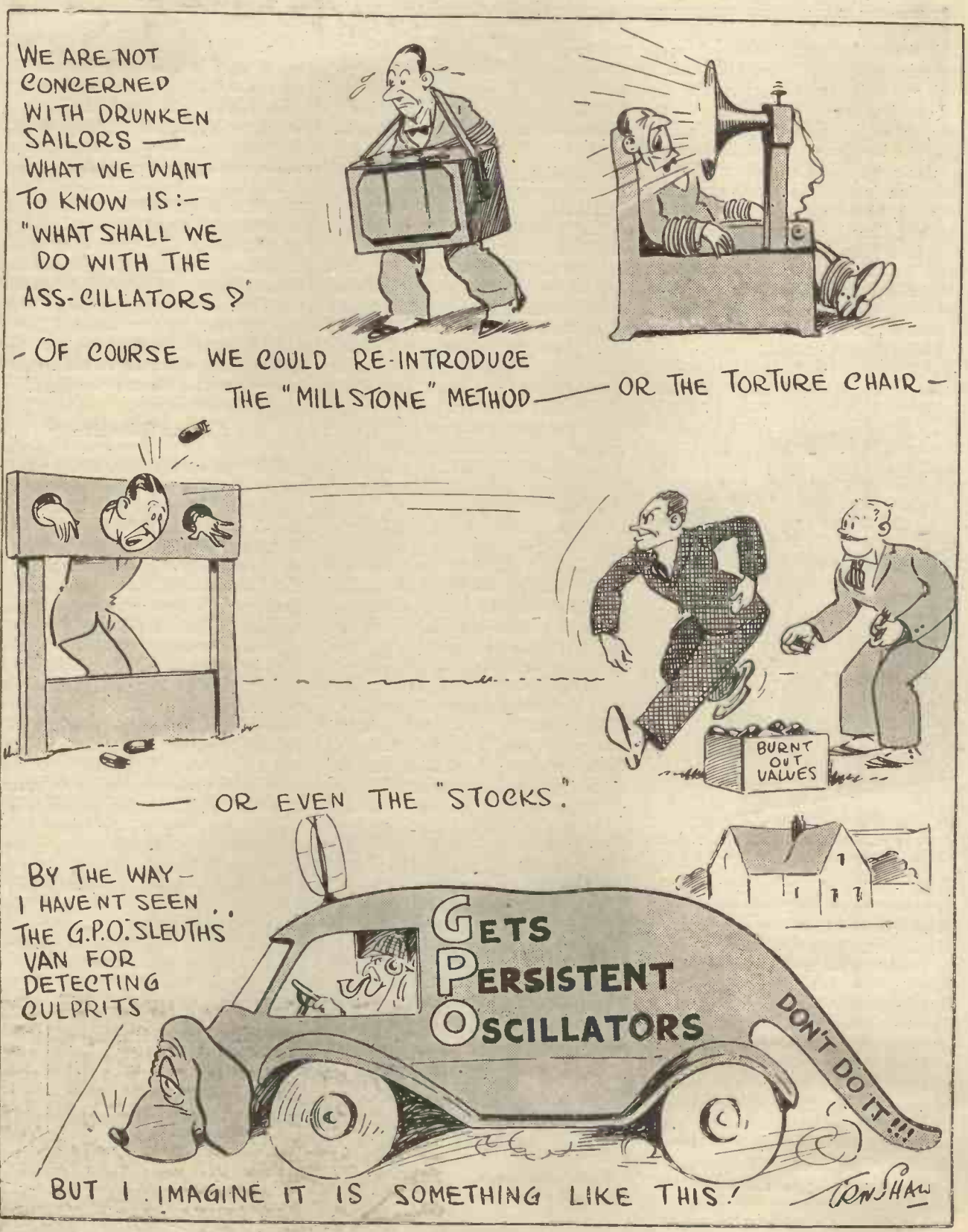
Just try the effect of making up a tuned anode set with astatic coils in screened compartments, and it is not unlikely that you will agree. As for the enormous positive potential needed upon its grid to hold it down to earth, I can only say that with anti capacity valves of the V.24 or D.E.Q. type a fraction of a volt sufficed at the worst of times, and often even this was not required.

Just as Selective

But, you will say, look at the vastly greater ranges and the much improved selectivity that you obtain nowadays. I will grant you the greater ranges, because nowadays we have valves with much bigger amplification factors than those available only a short time ago, whilst modern coils are distinctly more efficient. But as regards selectivity, despite the "heavy damping," I am still a heretic. Fitting my old tuned anode set with modern valves and modern coils, I obtain just as great selectivity as any neutrodyne set will give me, and I can run through the broadcast wave-band without raising so much as a squeak.



When the back-of-panel connections are complicated short circuits may easily arise. Whether these will burn out the valves or no will largely depend upon the L.T. to H.T. connections.


WE ARE NOT CONCERNED WITH DRUNKEN SAILORS — WHAT WE WANT TO KNOW IS:- "WHAT SHALL WE DO WITH THE ASS-CILLATORS?"
- OF COURSE WE COULD RE-INTRODUCE THE "MILLSTONE" METHOD — OR THE TORTURE CHAIR -
— OR EVEN THE "STOCKS".
BURNT OUT VALVES
BY THE WAY - I HAVE NT SEEN .. THE G.P.O. SLEUTHS VAN FOR DETECTING CULPRITS
GETS PERSISTENT OSCILLATORS
DON'T DO IT!!!
BUT I IMAGINE IT IS SOMETHING LIKE THIS!
TOM SHAW

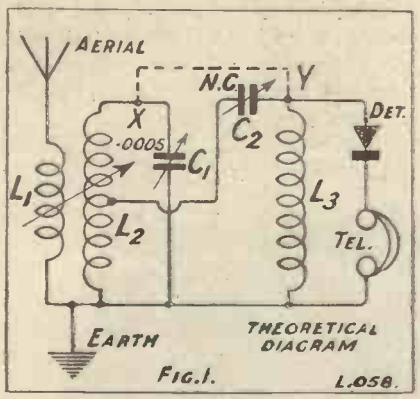
The "No Code" Crystal Set

A crystal receiver which definitely cuts out interference from unwanted stations.

By A. S. CLARK.

I HAVE seen it stated that selectivity is not a desirable quality in a crystal receiver, it being suggested that since there were only two stations which could be received, namely, the local one and Daventry, there was nothing to "select." It seems that the only possible reason for such a statement is lack of experience with crystal sets near the coast, or in districts situated just at the edge of the crystal region of a broadcasting station.

In the first case Morse signals from ships and shipping stations working on 600 metres are often strong enough



to completely drown the broadcasting. This trouble can only be overcome by a set with real selectivity.

In the second case, since signals are bound to be fairly weak, signals on neighbouring wave-lengths from commercial stations and tunable "mush" produced by high-power stations are often sufficient to completely spoil listening. This again is a trouble which can only be cured by selectivity. But in this case it is no use to obtain selectivity by sacrificing strength, as so often happens.

Damping Reduced

The crystal set described in this article is useful since it is just the receiver required by those situated in the circumstances outlined above. It is also interesting from the scientific side as showing what can be obtained in the way of selectivity from a crystal set. The damping of the aerial and the crystal are reduced in such a way that signal strength is not impaired by the wonderful selectivity obtained.

Original Circuit

A diagram of the theoretical circuit employed is shown in Fig. 1. and is worth studying whether the set is going to be constructed or not. The aerial is aperiodically coupled to the tuned coil by means of the small coil L_1. This method of making the aerial circuit semi-aperiodic seems to overcome the reduction of signal strength which is sometimes experienced when using an auto-coupled arrangement.

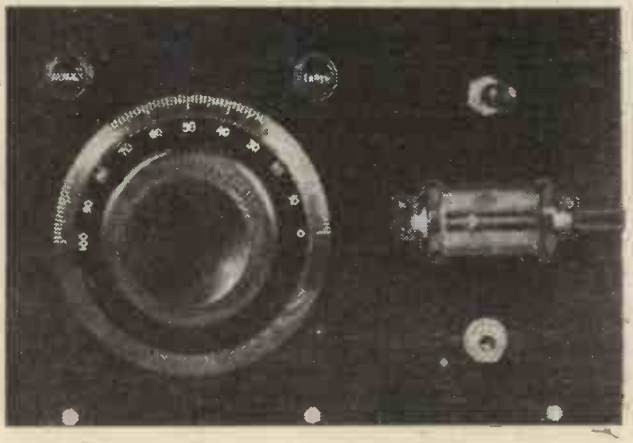
In order to decrease the damping of the crystal, a tapping is taken half way up the tuned circuit L_2 C_1, and so that a gradual fine adjustment of the coupling of the detector circuit to the tuned circuit may be obtained, this centre tap is connected to the crystal detector through the small variable condenser C_2. This condenser is of the type generally used as neutralising condensers and is therefore shown in the diagram as N.C.

The direct current which flows through the telephones must have a complete path somewhere, and since it cannot flow through the condenser C_2 the coil L_3 is shunted across the telephones and the detector. This coil while providing a suitable path for the direct current, is of such a size as to act as a H.F. choke and so does not by-pass the high-frequency currents. An ordinary plug-in coil is made use of in this position, and a Unimic and a Dimic coil are made use of for L_1 and L_2 respectively.

COMPONENTS REQUIRED.

- Panel 9 in. x 6 in. x $\frac{1}{4}$ in.
- Cabinet with baseboard 9 in. x 8 in. x $\frac{3}{8}$ in.
- Dimic coil and mount.
- Unimic coil and mount.
- Single open telephone jack.
- Telephone plug.
- 2 terminals.
- ·0005 S.L.F. variable condenser.
- 4-in. dial for above.
- Neutralising condenser.
- Coil mount.
- Crystal detector.
- Glazite wire, etc.

The particular arrangement employed is not, for several reasons, satisfactory for the reception of Daventry. A slight adjustment has to be made when receiving Daventry, but the circuit still remains fairly selective so that the local station will not be found jamming in on top of the high-power station. The coils L_1 and



The panel lay-out is extremely convenient and simple.

THE "NO CODE" CRYSTAL SET—*continued*

L_2 have to be changed for ones of suitable size, but no centre tap is made use of. The two points X and Y have to be joined by means of a piece of flex wire. It will be seen on looking at the back of panel diagram that these two points have terminals which make the attachment of the flex wire a simple matter. The coil L_3 has to be removed.

In a list will be found a description of all the components required to build this set. Makes different from those shown may be used provided they are of good quality and suitable. The sizes of the coils required will be found in a paragraph later in the article. When all the components required have been collected together the constructional work may be commenced.

Constructional Details

First of all mark out the panel in accordance with the drilling diagram given in Fig. 2. Care should be taken to see that the holes for the screws which fix the crystal detector to the panel are in exactly the right positions. In the case of the three large holes for the one-hole fixing components it is as well to drill a small hole first, which will act as a guide for the large drill.

When the drilling is finished the components may be mounted on the panel. This does not call for any comment except that the variable condenser should be placed the same way round as it is shown in the photographs. Next screw the panel to the baseboard. This should be done with the panel in the cabinet in order to ensure a proper fit. Now mount the coil holders on the baseboard in approximately the same position as shown in the back of panel diagram (Fig. 3).

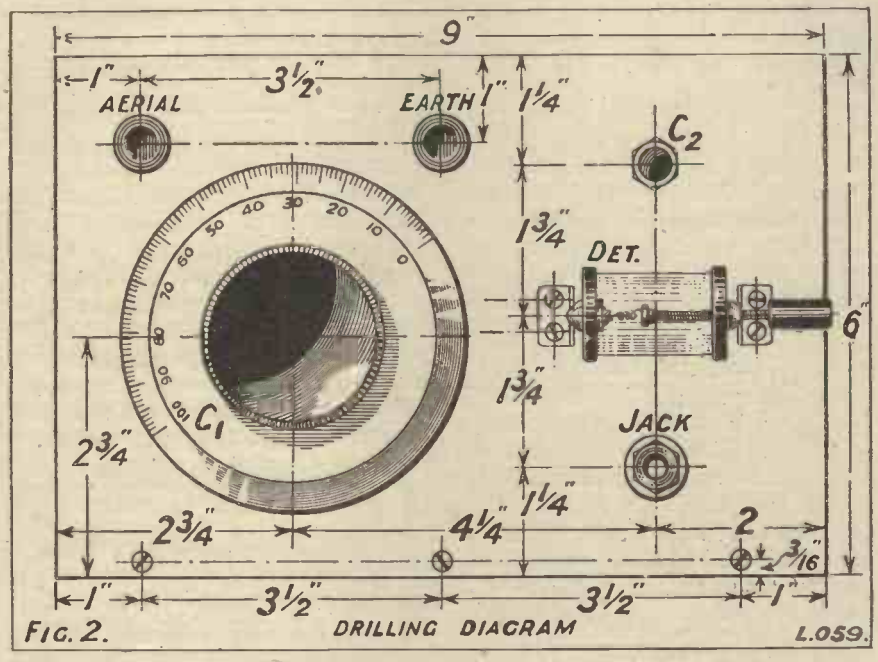


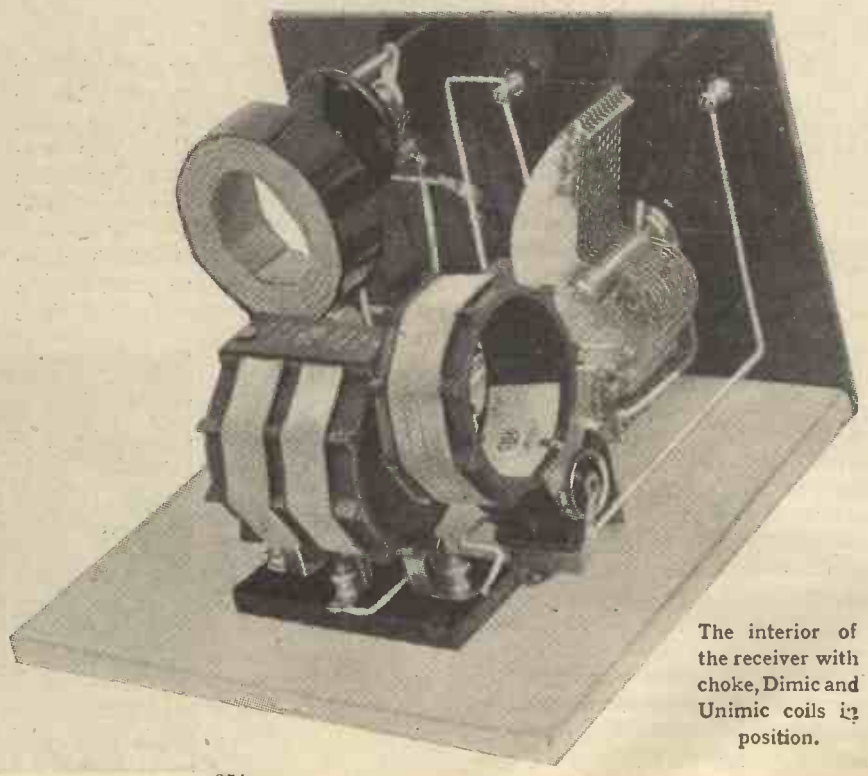
FIG. 2. DRILLING DIAGRAM L.059.

The wiring should be carried out in accordance with that shown, and in order to facilitate this part of the constructional work, wiring instructions will be found in words in another part of this article. The photographs of the back of the panel will also be found useful as a guide to the positions of the wires. Before any of the wires are actually attached it is as well to tin all points to which soldered connections are to be made. When the wiring is completed the set may be placed in its cabinet and tested out.

For reception of stations on the lower broadcast range a No. 25 Unimic coil will be required in the aerial and a No. 1 Dimic coil for L_2. For the coil L_3 an ordinary No. 250 coil should be used (the writer tried a No. 200, but while the set functioned quite well signals are distinctly stronger with the No. 250 coil).

Long Wave Reception

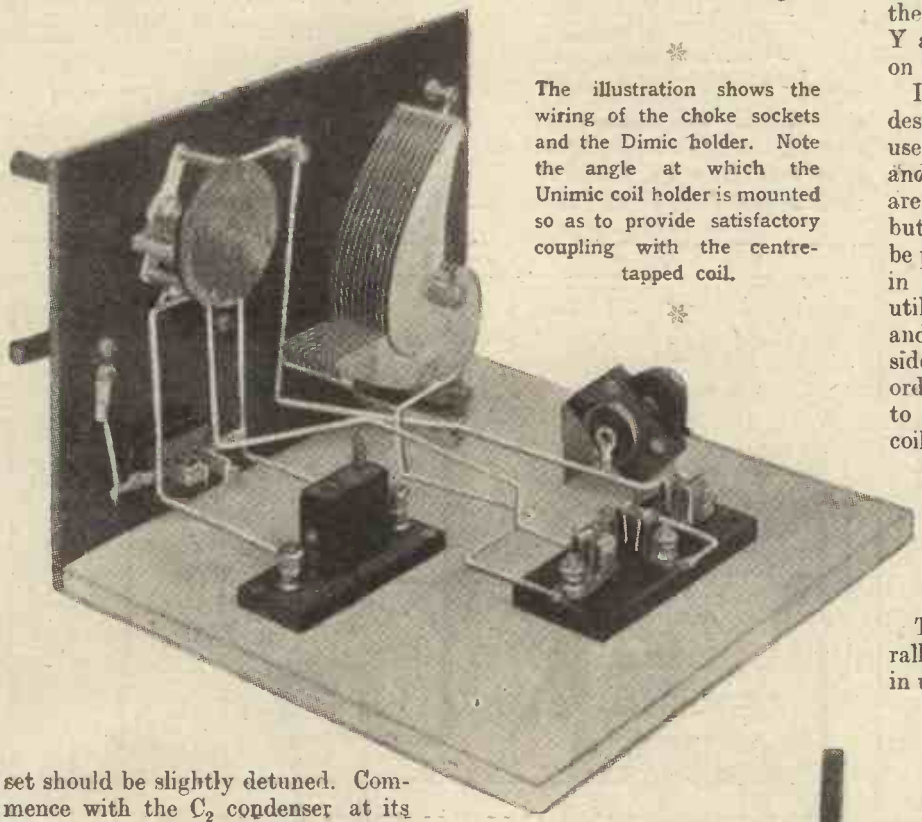
When reception of Daventry is required no coil will of course be wanted in the L_3 position. A No. 3A Dimic coil and a No. 150 Unimic coil will be required. It may be that some may not want to use the set on the high-wave range and in that case a saving in the cost of the coils will naturally result.



The interior of the receiver with choke, Dimic and Unimic coils in position.

THE "NO CODE" CRYSTAL SET—*continued*

It will be found best to have the coupling between the aerial coil and the secondary coil as tight as the arrangement will allow. When a good spot has been found on the crystal, the set should be slightly detuned. Commence with the C_2 condenser at its minimum position and gradually increase its capacity. Signals will suddenly come up in strength and then very gradually decrease as the capacity is increased still further. This may make it appear that the best results are obtained with this condenser all in, which is not the case. The condenser should be set at the point where signals suddenly come up in strength.



The illustration shows the wiring of the choke sockets and the Dimic holder. Note the angle at which the Unimic coil holder is mounted so as to provide satisfactory coupling with the centre-tapped coil.

Sharp Tuning

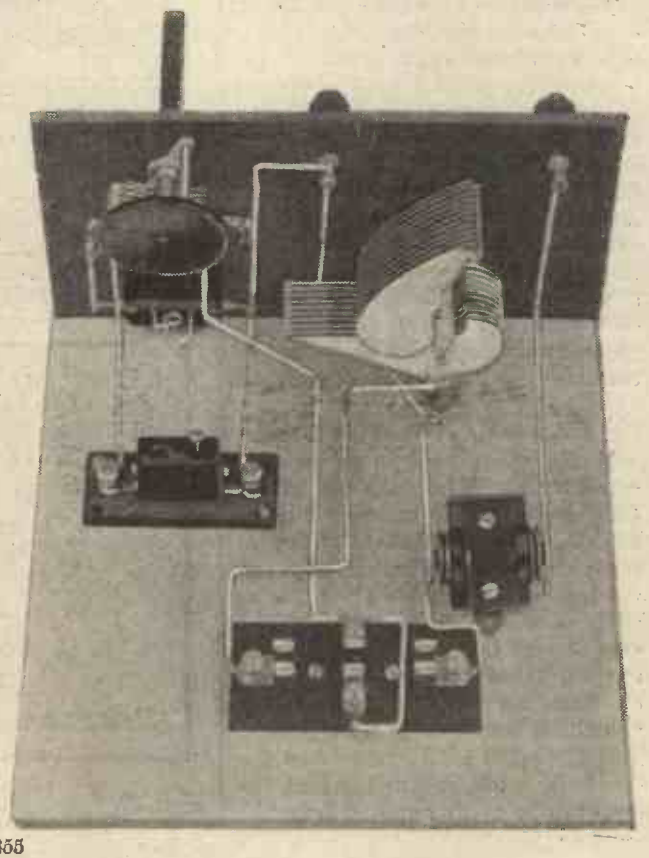
On test the set was found to be quite up to expectations. It was tested at about eight miles from the London station which came in at normal strength. Tuning was so sharp that if the tuning condenser was quickly rotated backwards and forwards for about 20 or 30 degrees across the position where the local station was tuned in, that transmission sounded like so many clicks. It was, in fact, possible to tune it right out in about 5 degrees either side of the tuning position.

Daventry was received at very good strength without any background from London.

If it is desired, for some reason or other (such as for comparing selectivity) to use a standard arrangement on the local station, it may be done quite easily. The coils as specified for the local station are left in position, and the coil L_3 is removed. Now, as in the case of reception from Daventry, the point X is connected to the point Y and tuning is carried out entirely on the condenser C_1.

It is just possible that some may desire to know if it is satisfactory to use plug-in coils instead of the Dimic and Unimic coils. If the plug-in coils are to hand they may be employed, but it is as well if the coils are yet to be purchased, to obtain those specified in the list of components. When utilising plug-in coils, the two coils L_1 and L_2 should be mounted side by side and about half an inch apart in ordinary coil sockets, care being taken to keep them at right angles to the coil L_3. For the lower broadcast band L_1 may be a No. 25 or No. 35, and L_2 a centre tapped No. 50 or No. 75 coil. For Daventry, L_1 may be a No. 75 coil and L_2 a centre-tapped No. 150 or No. 200.

The best size for the coil L_1 naturally varies with the particular aerial in use, and it is as well to try different



An end-on view which emphasises the extreme simplicity of the connections. Though bare tinned copper wire has been used in the original model, there is no reason why insulated wire should not be used if the constructor so desires, as long as good spacing is carried out between all connections.

KEEPING THE DRILL STRAIGHT

MANY practical readers will be only too well aware of the difficulty which is sometimes experienced in keeping a hand-drill in a perfectly upright position when drilling a hole in a panel. If the terminals and other panel components are to fit neatly in their respective positions, it is absolutely essential that the panel drill be maintained in a perfectly upright position during the whole of the drilling operation.

It is essential to hold the drill in a vertical position.

An experienced worker possessing a practised eye is generally able to drill holes perfectly straight by the aid of mere visual and mechanical judgment. Not so the beginner in radio constructional work, however.

However, by the use of the simple little device shown in the illustration, it becomes a comparatively simple matter to preserve the drill in a perfectly upright position when drilling a radio panel. The device consists of a small spirit level, of the type generally employed for attaching to cameras.

Easily Removed

If the spirit level is to be permanently secured to the top of the drill handle, it may be screwed down in that position by means of two or three very small screws. If, however, the level is required for other uses as well, as will most probably be the case, it may temporarily be attached to the drill-handle by means of a layer of Plasticine or Chatterton's Compound. Either of these materials will hold the spirit level securely to the drill-handle, but, despite this fact, the level can be easily removed from the drill-handle when occasion demands.

Any reader finding a difficulty in drilling straight holes in a panel may be strongly recommended to make use of the above little gadget, for by its aid the radio worker can tell instantly whether the drill is being held perfectly straight or not.

THE "NO CODE" CRYSTAL SET

—concluded from page 355.

size plug-in coils, especially in the case of reception from Daventry.

It must be remembered of course, that a centre-tapped secondary coil is essential if the set is to be really satisfactory. It could be adapted for use with ordinary coils but the chief advantage claimed for it would be forfeited by such a procedure.

WIRING INSTRUCTIONS.

Join aerial to one side of L_1.
Join one side of L_2 to remaining side of L_1 : same side of L_1 to moving plates of C_1 : moving plates of C_1 to earth : earth to contact 2 of jack : contact 2 of jack to pin of holder for L_3.
Join remaining side of L_2 to fixed plates of C_1.
Join one side of det. to contact 1 of jack.
Join moving plates of C_2 to remaining side of det. and socket of holder for L_3.
Join fixed plates of C_2 to both sides of centre tap L_2.

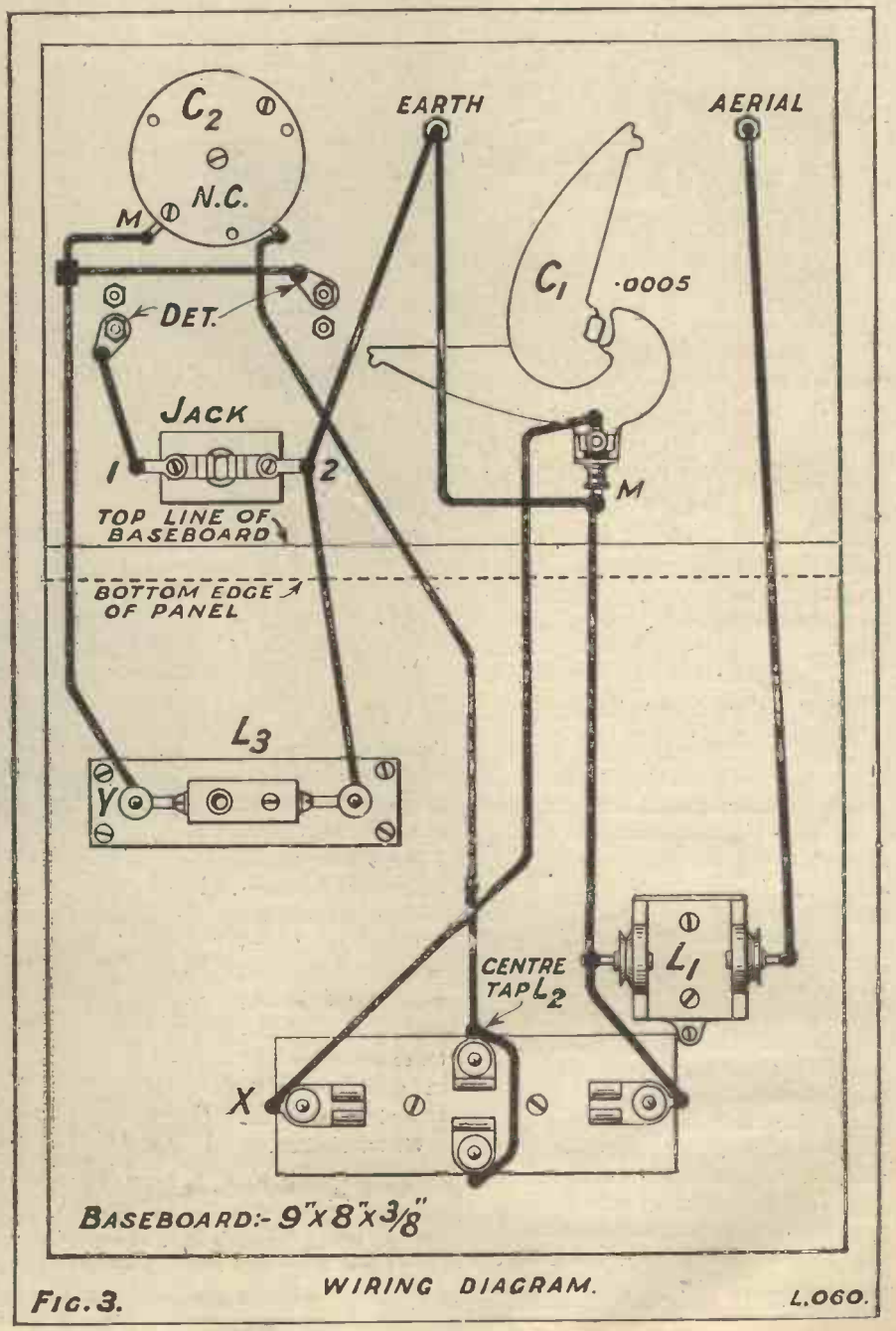


FIG. 3. WIRING DIAGRAM. L.060.

Direct & Indirect Waves

An interesting article explaining some of the latest theories in connection with the phenomena of fading.
By THE EDITOR.

THERE is a theory, fairly widely accepted, that when electro-magnetic waves radiate from the transmitter they become separated into two distinct portions. One portion is usually known as the direct wave, and it travels from the transmitter to the receiver over the surface of the earth. The other wave, known as the indirect wave, is supposed to move upwards and outwards from the transmitting aerial.

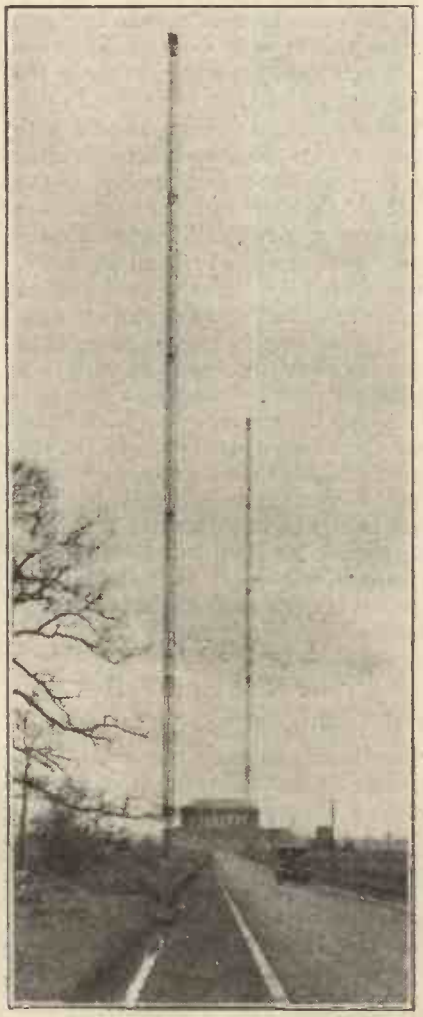
It is true that during the daytime the direct wave is more important than the indirect wave, because the latter seems to dissipate its energy in the upper portions of the atmosphere. During daylight hours the action of the sun's rays on the atmosphere causes the latter to become ionised, and consequently the energy of the indirect wave is sometimes considerably dissipated by the process of absorption.

Why Reception Varies

Therefore, if this theory is correct, it is natural to suppose that the direct wave is of the most importance; but even the direct wave, which does not suffer very greatly from absorption in the atmosphere, meets with drawbacks and obstacles which minimise its efficiency and value. For example, although the energy of the direct wave may not be absorbed to any great extent by the atmosphere, it is absorbed, when passed over land, by such things as vegetation, and especially by buildings which contain iron, steel and other minerals, and also by hills which contain metallic ore.

This is probably the reason why amateurs are continually noticing that at certain periods of the year they hear little or nothing of the signals from certain stations, especially medium and low-powered stations, working on fairly low wave-lengths at distances greater than one hundred miles or so away.

The process is almost reversed at night time, for when darkness falls part of the atmosphere quickly becomes de-ionised and it is the turn of the indirect waves to occupy the position of importance, for they are now able to travel without any great loss of energy to considerable heights—some physicists think as much as eighty thousand to one hundred thousand metres—and in such regions they strike what is generally known as the Heaviside layer.



The approach to the Rugby radio station

This layer is supposed to consist of an ionised belt of gaseous atmosphere, and when electro-magnetic waves are impinged upon this layer they are reflected back to earth again, and instead of passing out into space often travel in a track which leaves a mental impression of an inverted V. This is one of the reasons why signal strength is invariably stronger at night than daytime, and why it is generally noticed that signals can be heard at much greater distances at night time than in the daytime.

Night and Day Differences

Another reason why signal strength is greater in the night time is that energy is being received, not only via the indirect wave, but also, to some extent, from the direct wave.

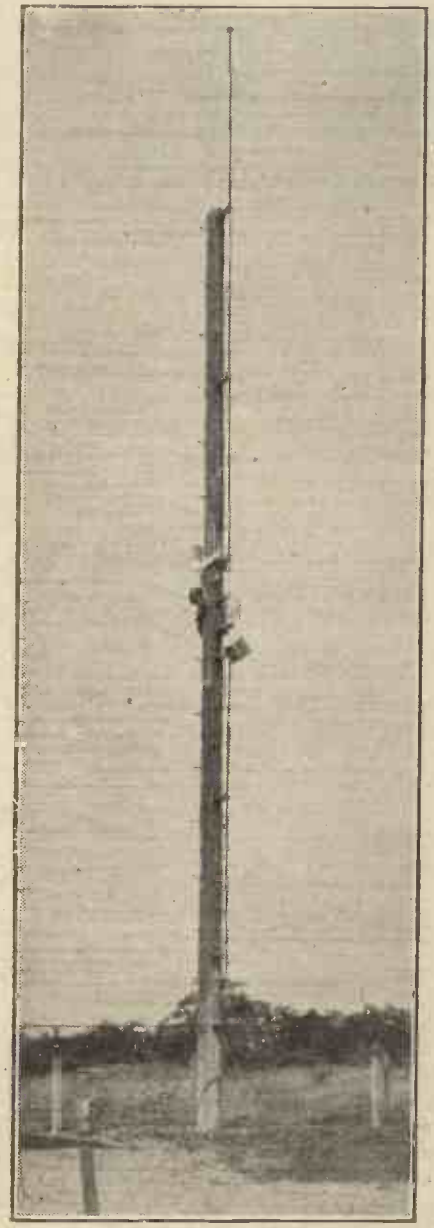
Although the latter does not play such an important part when darkness falls, there is nevertheless an additional energy which, when added to the energy of the indirect wave, is responsible for greater signal strength. This only applies, however, in cases where signals are received over medium distances. When the distance is very great the direct wave has little or no value, and it is the indirect wave which, being reflected down to earth again from the Heaviside layer, energises the receiving aerial.

Thus we have an explanation for the reason why certain stations, which cannot be heard at all in the day-

DIRECT AND INDIRECT WAVES—*concluded*

time, are received clearly and at good strength at night time.

This leads us to the question of fading, which is usually most noticeable at night time. This may strike



The vertical aerial used for short waves at KDKA

the new amateur as rather curious in view of the recent statement that the average strength of received signals is greater at night time than in the daytime, but this is because of the fact that besides reflecting waves back to earth, the Heaviside layer is also responsible for another effect on the indirect wave. The Heaviside layer, in fact, seems to "twist" the indirect wave.

Dr. Alexanderson, of America, has recently made some interesting experiments in this direction whereby he can produce what he calls the "corkscrew" effect in connection with transmitted waves. These experiments have also shown that a reflected wave from London had been turned, before reaching the receiving aerial, through an angle of 60 degrees, and it is thought that this twist phenomena, in connection with transmitted direct waves, is largely responsible for fading.

"Corkscrew" Variations

While at one time the two waves, the direct and the indirect, combine together and cause increased signal strength, at another time they will become more and more out of relation to each other, or out of phase, with the result that the amateur listening-in notices a distinct decline in signal strength.

Every amateur who indulges in the fascinating pastime of tuning in distant stations, is well acquainted with this troublesome phenomenon of fading and probably most readers have noticed that, although the local station may be received with perfect steadiness and excellent signal strength, reception from some distant station (although that distant station may have considerably greater power than the local station), seems to vary in a most peculiar and illogical manner.

At one instant reception is loud and steady in signal strength, while at the next it begins to fade away, decreasing and decreasing in strength until it can hardly be heard at all; and then a second or two afterwards the strength will start to rise steadily until it is quite loud and in every way satisfactory.

The Rise and Fall

It may hold this steadiness for some time and then quite suddenly decline again, and just as suddenly reach a crescendo of loudness.

It is worth while tuning your set so that the signals from a station at a distant point (the signals of which you have noticed are fading badly) can be carefully noted. Some interesting observations can thus be made. The writer has noticed, as no doubt many hundreds of other amateurs have done, that the decline and the increase of signal strength in such cases is often periodic, and that sometimes a double periodic effect can be noticed. That is to say, a spell of slow fading is followed by one which is much more rapid, and after that the slow fading effect will be noticed again.

Independent of Weather

This fading can affect wave-lengths up to as high as two or even three thousand metres; while down to three hundred metres, and certainly below, there is hardly a station which at one time of the year is not affected very seriously.

Another interesting point is that fading occurs usually on transmissions from stations about fifty miles or so from the receiving aerial, and, as we have stated, is worse during the hours of darkness.

Fading, however, seems to be a phenomena entirely independent of weather conditions, and the only thing which is known about it, which can be of any practical use to wireless engineers, is that it is much more marked on the lower than on the higher wave-lengths.

A remedy for fading has never been found, and probably never will be, for it is one of those little drawbacks to wireless science which Nature seems to have ordained as a warning to man not to take a good thing too much for granted.

A Reader's Results with Short-Wave Receiver

SIR,—With the Simmonds' short-wave receiver, as given in the February issue of MODERN WIRELESS, KDKA was received at moderate loud speaker strength on February 22nd, at 11-12 p.m.

At 12.10 a.m., February 23rd, WYG was also heard at slightly greater strength, the Ten Eyk Orchestra broadcasting from the Ten Eyk Restaurant. Both stations could also be heard on the 'phones with the detector valve only.

Those of your readers who have made this receiver may be interested to know that an excellent musical programme is given on Sunday evenings at 6.30 p.m. by 5 K H, 144, West Hill, Putney, on a wave-length of about 44 metres.

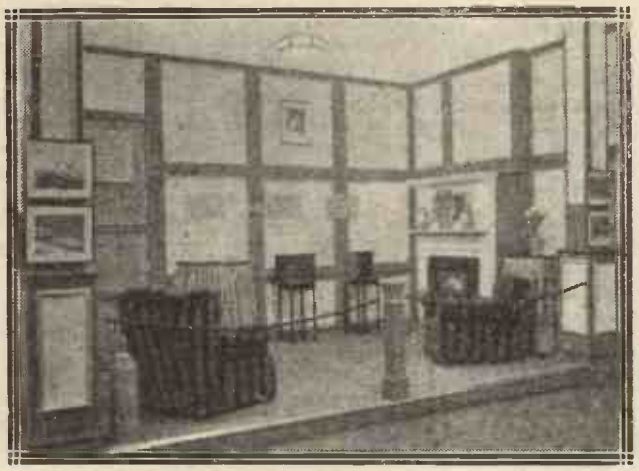
Yours faithfully,
W. W. WOODMAN,
Willesden, N.W.10.

My Broadcasting Diary

Under this heading month by month our Broadcasting Correspondent will record the news of the progress of the British Broadcasting Corporation, and will comment on the policies in force at B.B.C. headquarters.

Earlier Dance Music

IN response to a steadily growing demand for occasional early dance music from London, the B.B.C. are arranging to introduce this on Tuesday nights from 9.45 to 11 p.m. A special programme of more serious music will follow from 11 p.m. until midnight. The date of the inauguration of this feature is not yet announced, but it will probably be early this month. The change will be widely acclaimed by listeners. There has been an undue tendency lately at Savoy Hill to stereotype programme timing. Changes such as this should not be so infrequent as they have been in the past.



The B.B.C. drawing-room at the Ideal Home Exhibition showing three receiving sets in the background. The one with a curtain incorporates a loud speaker.

Passion Play by Miners

I confess to considerable interest in the projected broadcast during Passion Week of a play performed by working miners at Ellistown in Leicestershire. It is understood that the standard of performance attained by these miners is of a surprisingly high order. A kind of histrionic tradition has been developed in that neighbourhood dating from the early sixteenth century.

Bird Talks

The B.B.C. have in hand a series of talks on birds for mid-spring. It is anticipated that Lord Grey of Fallodon will be the broadcaster. Mr. Graves, one of the senior programme officials at Savoy Hill, is a nephew of Lord Grey.

Scarcity of Broadcast Drama

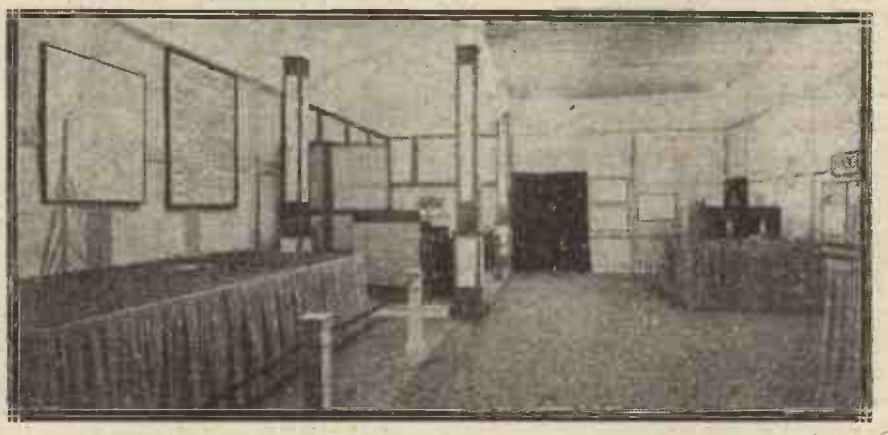
The Dramatic Producer at B.B.C. headquarters was complaining to me the other day of the paucity of material for his section of programme time. He explained that there was a marked division of opinion as to the best method of attracting likely plays for the microphone. Some people were in favour of big competitions with substantial money prizes. But the experience with the music competition organised by the B.B.C. last autumn was not encouraging. On the whole, opinion seemed to be moving in the direction of specific commissions of well-known writers. It is felt that there will be better return for money spent in this way than in sterile competitions. But it is curious that there is still no sign of the much-heralded new school of radio dramatists.

The Grand Prix d'Europe

The Grand Prix d'Europe, the greatest motor-racing feature of the year on this side of the Atlantic, which is run at Brooklands on October 1st, is to be broadcast in a special O.B. narrative.

The Sports Broadcasts

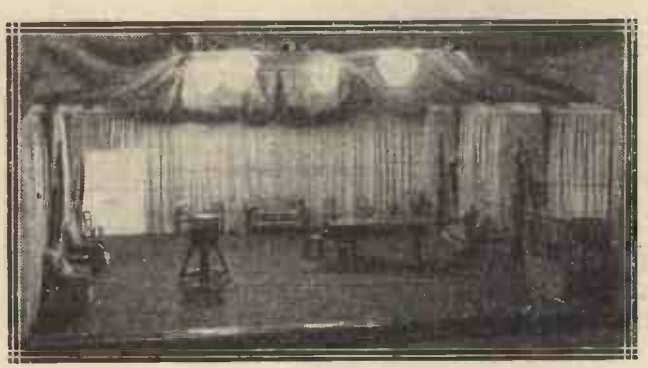
The B.B.C. appear to continue to gain ground with their broadcasts of sporting events. There is, however,



Another part of the B.B.C. section at Olympia. On the left is a large scale model of Daventry

MY BROADCASTING DIARY—*concluded*

a growing volume of opposition which may prove embarrassing and, perhaps, even crippling, later on. Some of the Soccer clubs have stood out, notably at Nottingham and Liverpool. A good many other clubs are indifferent, and only a few are really keen on broadcasting. On the other hand, the Rugger authorities are all keen, and the managements of other sports are not hostile. Then, curiously enough, the Saturday afternoon running narratives—so warmly received at the beginning—are by no means as popular with the average listener as they were. This is not the fault of the B.B.C., whose efforts are regarded as first-class. It is simply that, except for those who are really keen, the substitution of a sport broadcast for the usual Saturday afternoon concert is not acceptable to the majority of regular and appreciative listeners. To meet this point and still to retain the sport lovers, the B.B.C. have been trying an experiment in putting out only one half of a game from one station. It is doubtful if this will succeed. Better to call the thing off entirely than compromise with it. Here is yet another example of the troubles experienced in the absence of alternative programmes.



The model of the large studio at 2LO exhibited at Olympia by the B.B.C.

The Last Albert Hall Concert, April 14th

For the last of its twelve National Concerts at the Royal Albert Hall, the B.B.C is organising a special treat both for those who attend at the hall and for those who listen at home. Schonberg will conduct a performance of his own work "Gurrelieder." This is regarded as a popular work, and is one which has not yet been performed in this country. The conclusion of the series should mark the final triumph of the most ambitious artistic effort so far undertaken by any broadcasting organisation in the world. The B.B.C. set about their self-allotted task with characteristic vigour, vision, and determination. They scoured the artistic centres of the Continent and of America for the best conductors and artistes. They got together a special orchestra of 150 players. No expense was spared. The series was undoubtedly a tremendous success, and has done a great deal of good, not only for broadcasting, but also for music in this country. The attendances at the hall itself have not been satisfactory, but the B.B.C. were very wise not to waste large sums of licence revenue on advertising for the purpose of trying to fill the hall. There were quite enough people present to stimulate the orchestra, artistes, and conductor. For the rest, the transmission was so uniformly good that listeners enjoyed the music as well at home as if they were present in the hall. But the effort was a great one, calling for sound organisation, which was duly forthcoming. I congratulate the B.B.C. on their series of National Concerts. One wonders what they can undertake next season to go the "one better" they are always striving for.

The Governors at Work

Savoy Hill has maintained an impenetrable silence about the activity or inactivity of the new governors, those "mysterious directors" held up to ill-deserved ridicule by Arnold Bennett. From what little I have been able to glean on the subject, I have no doubt in my mind that the early misgivings were largely unjustified on most counts. They have been applying themselves diligently to learn about the many-sided activity of this great strange new service for which they are now responsible.

A New Irish Feature

The B.B.C. are likely to begin in May a new weekly Irish humour feature. The originator of the idea is Mr. Charles Hands, the well-known Irish comedian. A brief topical review from an intensely Irish angle would be tremendously popular. Francis Hackett, the brilliant Irish American, is also adding to his successes at the microphone.

Model of a B.B.C. control room which formed another interesting exhibit at the "Daily Mail" Ideal Home Exhibition.

An L.S. Blending Unit

A novel device which enables two loud speakers to be "blended," with the result that the quality of reproduction is considerably improved.

By C. A. OLDROYD.

DURING the last year or two loud speakers have been improved beyond recognition, and with a good set and an efficient amplifier, speech and music can be reproduced with remarkably good quality and volume.

Many amateurs will have noticed that, speaking in a tone sense, some broadcast stations come in more naturally than others; for some time, the writer's favourite station was San Sebastian. When the British broadcast stations had been put to bed, this station was tuned in, if it happened to be "on the air," and rarely did other transmission come in as naturally as that of the far-away Spanish station.

Speaker That Specialised

With a different loud speaker, San Sebastian seemed less good, and finally, after testing various makes of loud speakers, the secret of San Sebastian was solved. The high-pitched music usually sent out from this station fell within the tone range which the first speaker could reproduce most faithfully. In other words, the loud speaker was a specialist on the higher notes, and in its own field it was hard to beat.

What was obviously wanted was a second speaker which would just as faithfully deal with the lower notes. Two speakers of different makes connected in series performed considerably better than the first speaker alone; each speaker had different characteristics, and, run in harness, they rendered music and speech far better than either by itself. (Fig. 1.)

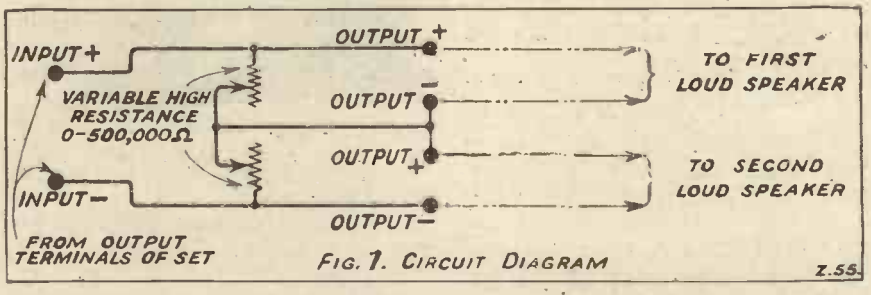


FIG. 1. CIRCUIT DIAGRAM

The next step was an attempt to control each speaker by itself; a variable high resistance was placed over each set of speaker terminals, and even a very rough experimental hook-up proved most satisfactory. In this case, home-made resistances were used, a copper tongue moved over a circular graphite track.

Components Required.

Ebonite panel, 7 in. by 3½ in.
Two variable high resistances, either 0 to 500,000 ohms or 0 to 1 megohm.
Indicating terminals: 1 "Input Plus," 1 "Input Minus," 2 "Output Plus," 2 "Output Minus."
Two dial indicators.
Busbar or Glazite for wiring up.
Wood for cabinet.

Constructional Details

For convenience in use two commercial high resistances were mounted on a small ebonite panel fitted in a miniature sloping front cabinet (Fig. 2). The circuit of this blender unit is given in Fig. 1. The two input terminals at the left are connected to the loud speaker posts of the set; the leads from one speaker go to the two upper output terminals at the right; the other speaker is connected to the two lower terminals. The two speakers are now connected in series, and a variable high resistance is

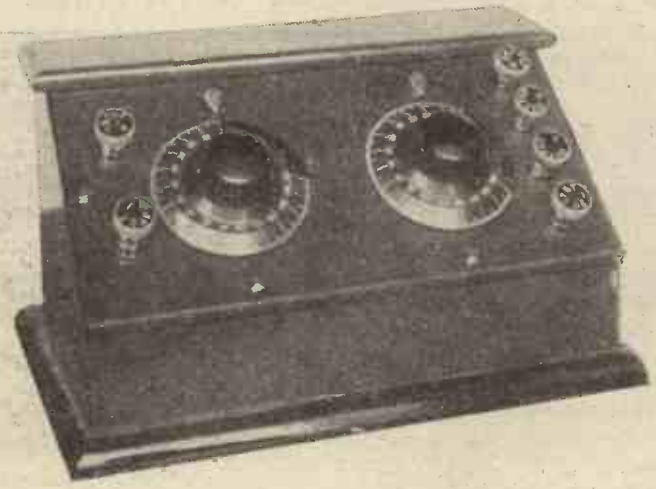


Fig. 2. The completed instrument, which, as will be noted, is a neat, distinctive instrument.

AN L.S. BLENDING UNIT—*continued*

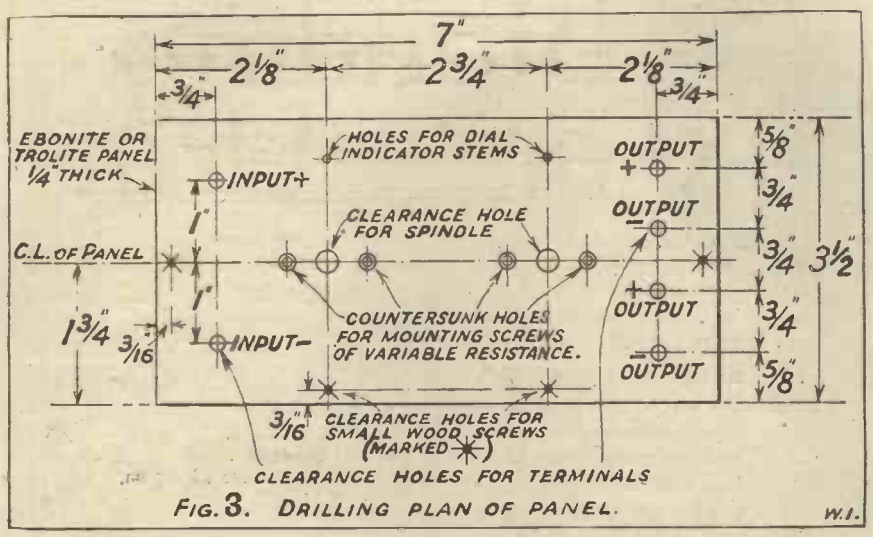


FIG. 3. DRILLING PLAN OF PANEL. W.I.

shunted over each pair of speaker terminals. The output of each speaker can be controlled by altering the value of the resistances; for different speakers the dial settings will naturally vary a great deal.

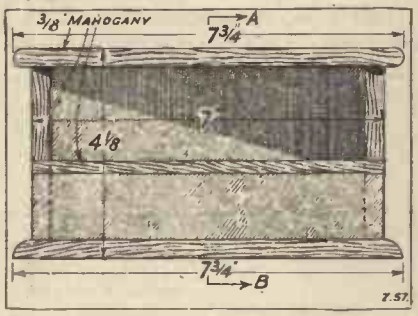


Fig. 4. Front elevation of cabinet.

Constructionally, the blender unit (Fig. 2) offers no difficulties; the small panel can be obtained cut to size from a dealer; the panel size shown in the drawings need not be strictly adhered to. The small cabinet illustrated was made up from thin mahogany cuttings; to simplify the work still more, the blender panel can be built into one of the inexpensive cabinets covered with imitation leather.

Fig. 6 shows a rear view of the panel with the resistances in position and the wiring completed; the drilling plan is given in Fig. 3. Square busbar was used for the wiring in the model illustrated, but Glazite or a similar insulated wire may be used instead.

The variable high resistances should cover a range from zero to one-half or one megohm; in the model shown two Royalty resistances type E were fitted. As alternatives, Marconiphone resistances or Igranic tone controls are suggested; in this case the panel may have to be made slightly larger to avoid crowding.

The Cabinet

The photo Fig. 5 shows the appearance of the home-made cabinet; it was made from cuttings ⅜ in. thick. Thinner wood may be used if available, but more care will have to be taken with the joints to prevent splitting. For the sake of appearance, the little cabinet should be french polished; if one of the polishing outfits intended for amateur use is obtained, and the directions enclosed carefully followed, the amateur polisher will meet with no difficulties. (Messrs. Hobbies market such an outfit.)

At first sight, plain terminals would appear to serve just as well as the indicating terminals fitted to the model illustrated, but indicating terminals have one advantage, they show the polarity of the connections and prevent demagnetisation of the speaker magnets due to incorrect connections.

Placing the Speakers

The completed blender unit may be placed close to the set, to be easily

Fig. 5. The cabinet.

accessible. Regarding the disposition of the two speakers in the room, many interesting possibilities are open to the experimenter. For instance, the two speakers may be placed close together, as shown in Fig. 9, where the smaller speaker is slightly raised to bring its flare in line with that of the larger loud speaker.

Or one speaker may be placed close to the set, the other being accommodated in a different part of the room, say on top of a bookcase. Finally, both speakers may be located at some distance from the set, and fairly high up, as shown in Fig. 8. If the place selected lends itself to the following modification, both speakers may be hidden behind a curtain of light and very thin material. This reduces the volume to some extent, but with our modern powerful sets a slight loss in volume is of no account.

Twin bell wire is advisable for the leads from blender to speakers—if they should be mounted some distance from the set—since this wire is easily tucked away behind the

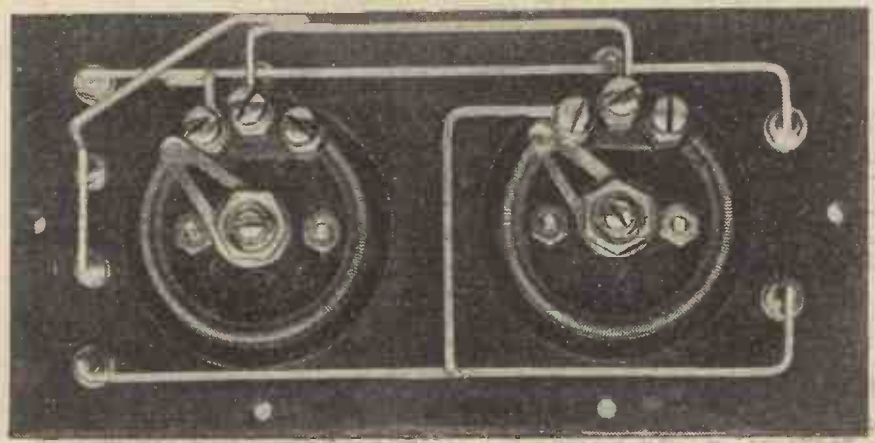


Fig. 6. The wiring is quite simple and perfectly straightforward.

AN L.S. BLENDING UNIT—*concluded*

picture moulding. Furthermore, one of the leads in each twin wire is provided with a coloured tracer cord, and there is less likelihood of making a mistake when connecting up.

At the set end, the bell wire leads may terminate in a wall connection jack, to avoid breakage in the leads due to constant handling and bending. Incidentally such an arrangement looks far neater when fitted in a living-room.

Controlling One Speaker

Truly life-like reproduction becomes possible if a cone and a horn speaker are worked off the blender; the cone is very good on the lower notes, the horn speakers are generally better on the higher notes. The writer has tried this arrangement with some of the latest types of cones, and both the C.A.V. Musicola and the Celestion cone performed exceedingly well,

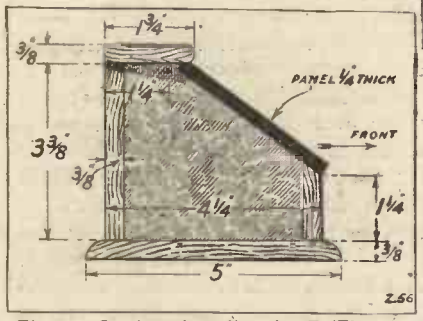


Fig. 7. Section along line A—B (Fig. 4).

although it is only fair to add that the latter make particularly was almost as good by itself. This brings us to the question of controlling only one loud speaker with the blender unit; in this case the top and bottom output terminals (on the right, Fig. 2). should be used, and one of the resistances set at zero. The volume is now controlled with the other resistance.

Placing the Speakers

No hard-and-fast rules regarding the best position for loud speakers in a room can be laid down, for the acoustic properties of rooms vary enormously.

Not only does the size and shape of a room affect it from this point of view, but the contents, and nature of the contents, also have a most important bearing on this subject.

Further, even the composition of the walls and the mural decorations will affect the reproduction from one or more speakers.

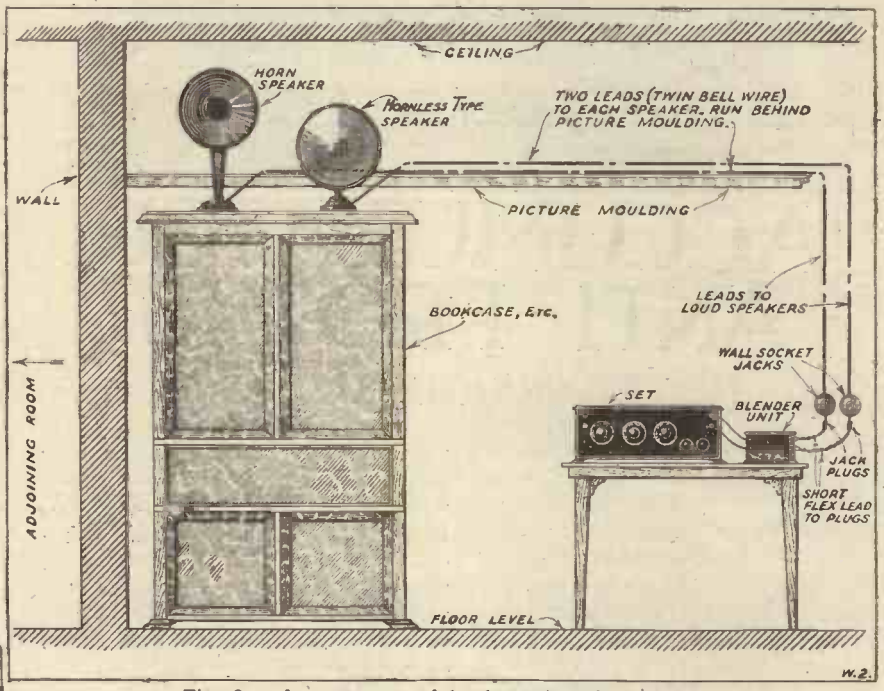
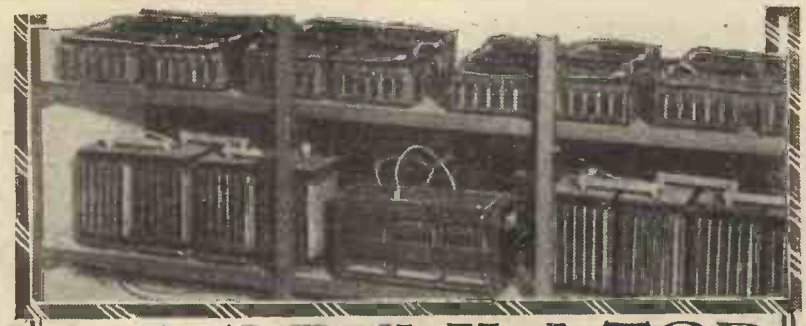


Fig. 8. Arrangement of loud speakers in a room.

Therefore, amateurs should make at least a few experiments before they finally decide upon the disposition of their speakers. They will be surprised at the difference minor variations in position will make.

Not only must the area in front of a speaker be considered and the nature of the surfaces upon which its main emission will impinge, but the background, and, in fact, the whole surroundings can all affect results.

Fig. 9. Even two speakers of the horned type can be used together with advantage, although better results can generally be obtained when cone and horn types are "blended."



ACCUMULATOR ANTI-FROTHS

By J. F. CORRIGAN, M.Sc. A.I.C.

SOME time ago there appeared on the market several brands of powdery substances, known categorically as accumulator "anti-froths." A small quantity of one of these substances is added to the accumulator acid during the later stages of charging in order to keep down the frothing tendency.

Now, it is a fact that such accumulator anti-froths do suppress the frothing, and, in many instances, to a surprisingly large degree. Unfortunately, however, the use of such substances very quickly gets the accumulator into a dirty condition. As often as not the plates become clogged up with impurities, and thus the efficiency of the accumulator—electrical and otherwise—quickly diminishes.

When an accumulator begins to gas or to froth, its charge is nearing completion. In fact, many professional accumulator chargers welcome the appearance of the bubbles of gas, for after an accumulator has been freely gassing for some time, it may be taken as a sign that the charge has been completed.

Corrosion of Terminals

Despite all this, however, accumulator frothing is a nuisance, and sometimes an abominable one. For one thing, if the cell froths too freely, quite a considerable amount of the acid is lost. Further, when each bubble of gas reaches the surface of the acid in the cell, the skin of the bubble bursts, and a fine spray of sulphuric acid is scattered about. Corrosion on the under-parts of terminal fittings may be caused. One way to stop this is to use one of the many accumulator anti-frothing materials which are to be obtained.

But are these latter materials worth while? Probably they are for the professional accumulator charger, who from time to time has entrusted to him the charging of large open-celled accumulators, accumulators in which any serious amount of frothing would do harm to objects in the vicinity of the cells. However, in the case of the small accumulator-charger, the matter is a different one, as the following considerations will show.

Metallic Salts

There are quite a number of metallic salts, such as ammonium phosphate, for instance, which, if added in small quantities to an accumulator, will repress the tendency of the latter to froth. The use of these salts, however, is dangerous, for the simple reason that the acid becomes contaminated with extraneous metallic substances which ultimately find their way to the plates, and so reduce the electrical efficiency of the active material on the latter.

A "Modern Wireless" six-valve set built by one of our readers.

The commonest anti-frothing material which is used, however, is not of a strictly metallic variety. It consists of ordinary dry soap, which is, of course, marketed under various names.

Now, there is no doubt about the fact that if a small pinch of dry soap is added to a frothing accumulator, the frothing will very often quickly subside. In practice, however, it is found that this suppression of the objectionable frothing is not very prolonged. After ten minutes or so, the frothing generally appears again, and this time, if anything, it attains still worse proportions. Hence, the addition of dry soap in this manner to a frothing accumulator is not a cure for the trouble; at the best it is only a palliative.

Weakens the Acid

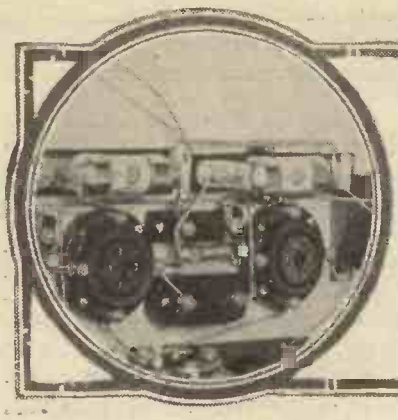
The soap acts by altering the physical nature of the liquid electrolyte, so much so that the bubbles of gas which are given off by the plates find it more difficult to break violently through the surface skin of the liquid, and thus to create the objectionable acid spray.

Consider, however, what happens when a small quantity of soap is added to an accumulator. Ordinary dry soap contains, first of all, a certain proportion of pure soap; that is to say, of a compound formed by the union of an alkali with a fatty matter. In addition to this, dry soap contains free alkali as an impurity, and also a small quantity of silica, and other insoluble matters.

Now, when you add soap to the accumulator acid in this manner, the free alkali is at once neutralised by the accumulator acid. Hence, the acid loses some of its strength. The silica and other insoluble impurities of the dry soap either sink to the bottom of the accumulator or becomes entangled in the plates. Thus appears objection number two.

But the greatest objection of all is to be seen in the fact that the greasy or fatty matter liberated by the soap, in contact with the acid, must inevitably tend to clog up the active material on the accumulator plates.

Perhaps the best method of all is to procure some mineral oil such as "Blancol" and pour a layer of this a quarter of an inch thick on the surface of the acid. This will have no bad effect on the plates, nor will it affect the acid, while at the same time it successfully prevents the spraying of acid that is so objectionable when the accumulator commences to gas.



Resistance Capacity Problems

An article which should prove of the utmost value and interest to all loud speaker enthusiasts.

By
R. W. HALLOWS, M.A.

THERE used to be a common belief that any fool could make an L.F. amplifier. That was in the days when such broadcast transmissions as took place were conducted by means of apparatus that we should regard nowadays as antediluvian, when it was of little use to go in for refinements in the receiving set owing to the poor quality of the transmission, when practically the

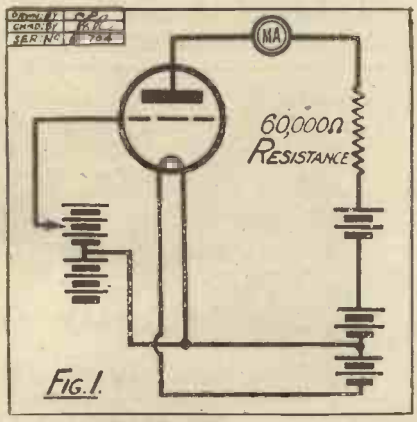


FIG. 1.

only coupling used for note-magnifying valves was the L.F. transformer which had been designed primarily for dealing with Morse signals. At that time, the general purpose valve was the only type available to all but millionaires, and when the very fact of hearing anything at all by wireless in the way of telephony provided such a thrill that nobody cared very much whether speech was woolly and music sounded like the wheezings of the world's worst gramophone playing a cracked record with a blunt needle! We have progressed a little since then.

Quality of Transmissions

The quality of the transmissions is now so excellent that they are to all intents and purposes free from distortion, whilst both the highest and the lowest musical pitches produced by the playing of an orchestra or a solo instrument are sent out into the ether with their full value. Though any fool can still make some kind of note-magnifier, most of us realise that to design and construct one capable of giving first rate results from the loud speaker is one of the most difficult and interesting problems in the whole of wireless.

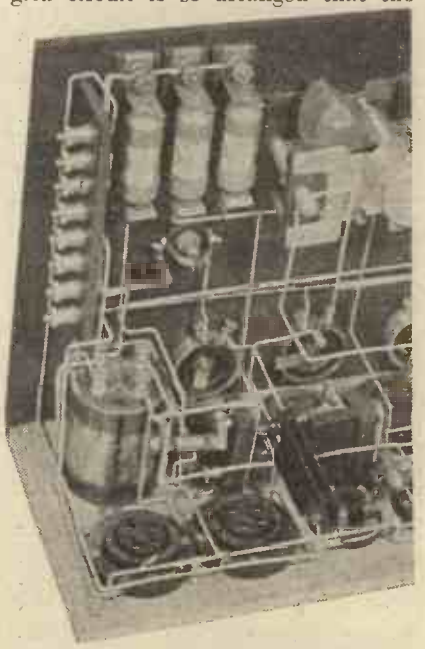
We are concerned in the present article not with L.F. amplification in general, but with that form in which use is made of resistance coupling. Before we get down to the problems which arise in connection with this particular type it may be as well to discuss briefly the way in which the resistance-coupled note-magnifier functions.

A Transformation

Everyone nowadays knows that if oscillating potentials are applied to the grid of a valve their effect is to produce *current* changes in the plate circuit. The L.F. amplifier follows immediately after the rectifying valve. To make any valve work we must apply to its grid not current but voltage changes. How are we to convert into *voltage* variations the *current* variations which, as the well-known grid-volts anode-current curves show us, occur within the rectifier? The only means of doing this is to place in the anode circuit of the rectifying valve a component which has impedance. Impedance is a complicated quality depending upon resistance, frequency, capacity and inductance. Its net effect upon an oscillating current is very much the same as that of resistance upon direct current. In a word, it opposes change in the value of the current; if the impedance is infinite no oscillating current can pass, just as no direct current can pass through an infinite resistance.

An impedance may in theory take the form of a resistance, an inductance, a capacity, or a combination of the three. In actual practice it must always consist of a combination of the three, since any conductor possesses inductance, resistance and capacity.

The practical form of impedance which comes nearest to possessing but a single one of these three qualities is a resistance. If it is well designed and made, and if the wiring is carefully carried out both inductance and capacity will be so small as to be negligible for all practical purposes. Actually they are so small in the case of the best anode resistances that we can afford to disregard them in our ordinary calculations. This means in the first place that the plate circuit of a resistance-coupled valve behaves very much as if it contained resistance only, and secondly that we can obtain a very good idea of its working by means of the circuit shown in Fig. 1. Here a milliammeter is placed in the plate circuit and between this and the H.T. battery is a resistance. The grid circuit is so arranged that the


R.C. stages do not occupy much space as this photo shows. Three stages are embodied in this set.

RESISTANCE CAPACITY PROBLEMS—*continued*

potential upon the grid can be varied by means of tapped batteries.

Since we are working here with direct current we can forget for a moment the word impedance and use resistance plain and simple in its stead. If we raise the grid potential to a positive figure more electrons pass

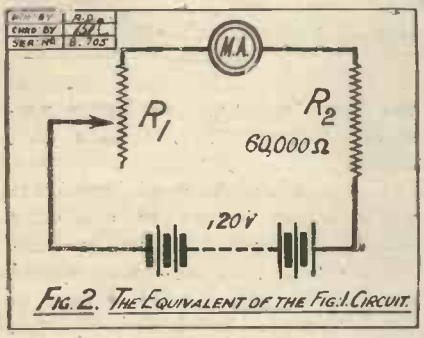


FIG. 2. THE EQUIVALENT OF THE FIG. 1 CIRCUIT.

from the filament to the plate; in other words the plate-filament resistance of the valve is decreased. Similarly by making the grid more and more negative we increase the internal resistance of the valve. The circuit thus contains two resistances, that within the valve and that in the plate circuit. Of these, the former is variable, whilst the latter remains at a fixed value.

Voltage Drop

We can redraw this circuit in a very much simplified form in the way shown in Fig. 2. Here R_1 is variable, whilst R_2 is fixed. Ohm's law tells us that the voltage drop across a resistance is equal to amperes multiplied by ohms. Supposing that we adjust R_1 to a value of 40,000 ohms, the resistance of R_2 being constant at 60,000 ohms, the total resistance

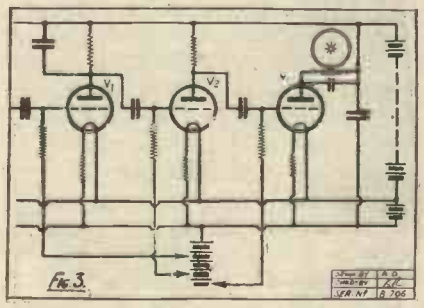


FIG. 3.

in circuit is now 100,000 ohms, and in the case shown the milliammeter will show that the current is 1·2 milliamperes, or ·0012 ampere. The voltage drop across R_2 is thus 60,000 × ·0012 or 72 volts. If we increase R_1 to 60,000 ohms, 1 milliampere of current flows through the circuit and the drop across R_2 is ·001 × 60,000 or 60 volts. Lowering the value of R_1 to 20,000 ohms makes the current-flow 1·5 milliamperes and the drop across R_2 ·0015 × 60,000 or 90 volts. Thus changes in the resistance of R_1 cause changes in the potential drop across R_2; if the value of R_1 is increased the potential drop across R_2 is reduced and *vice versa*.

Degree of Amplification

This is very much what happens in a valve functioning as a resistance-coupled amplifier, the net result being that voltage fluctuations upon the grid cause similar voltage fluctuations on an amplified scale across the anode resistance. In a typical resistance-coupled circuit such as that shown in Fig. 3, these voltages are applied to the grid of the following valve by way of the grid condenser, which has two duties to perform. It acts as a coupling between the plate of one valve and the grid of the next, allowing oscillation potentials to pass. It acts also as an insulator to direct current, preventing a large steady positive potential from the H.T. battery from reaching the grid of the valve.

One of the most important things to remember in designing a resistance-coupled note-magnifier is that the whole of the amplification must take place within the valve itself; there can be no voltage step-up such as is obtained by using a transformer whose secondary contains more turns than its primary. For this reason it is desirable to use in the early stages of the amplifier, valves with a big magnification factor; and here we are faced by one of our first problems—how to take full advantage of the amplification factor of a given valve. The greater the anode resistance is in proportion to the internal impedance of the valve the nearer will the magnification actually obtained approach the figure given as the amplification factor of the valve. In theory the actual amplification would be equal to the amplification factor if the resistance in the anode circuit were infinite. In practice a value equal to from five to ten times that of the valve impedance is found generally satisfactory. We can discover the amplification obtainable by means of the simple formula:

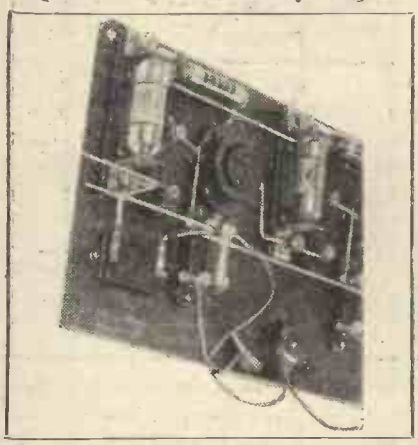
$$A = \frac{\text{plate resistance}}{\text{plate resistance} + \text{valve impedance}} \times \mu$$

where A is the actual amplification and μ is the amplification factor of the valve. Suppose, for example, that we propose to use for the first note-magnifier a valve such as the S.P.55B, which has an amplification factor of 35 and an impedance of 55,000 ohms, with an anode resistance of 500,000 ohms, then the amplification obtainable will be:

$$\frac{500{,}000}{555{,}000} \times 35$$

or approximately 31.

It not infrequently happens that a constructor who has chosen a valve with a large amplification factor, and has fitted a suitable resistance in its plate circuit, finds that when he comes to test out the apparatus the results obtained are distinctly disappointing. He is certainly not getting an actual amplification of 31, or anything like


R.C. stages are easy to wire up but component values require to be carefully chosen.

it. In such cases the cause of the trouble is usually to be found in the grid leak of the following valve, and this brings us to a second problem of some importance.

An Important Point

Not everyone realises that so far as alternating impulses are concerned the grid leak must be regarded as in *parallel* with the plate impedance that precedes it. An examination of Fig. 4 will make this point plain. On reaching the point A oscillating impulses have two paths to earth. They can travel *via* R_1 and C_2, as indicated by the first set of arrows, to L.T. negative and so to earth; or they can pass to earth by way of C_1

RESISTANCE CAPACITY PROBLEMS—*continued*

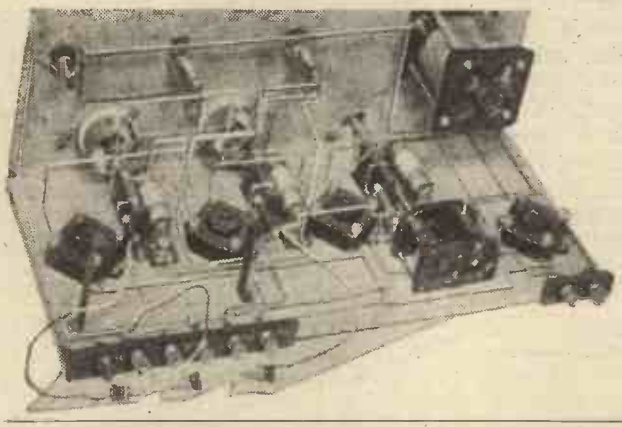
and R_2. The two impedances are, therefore, in parallel, and the total impedance between the point A and earth will be less than that of either of them. If, therefore, we employ, as I have seen done, an anode resistance of 500,000 ohms and a grid leak of 100,000 ohms, the impedance in the plate circuit of V is quite small and very little amplification is obtained. It is clear, then, that the grid leak must have a considerably higher value than the anode resistance. In practice a value for the grid leak of from four to eight times that of the anode resistance is usually suitable.

Grid Leak Values

Here, however, we are brought up by the problem No. 3. We cannot increase the value of the grid leak beyond a certain point, which depends upon the particular valve in use as V_2, for if we do so we shall find ourselves faced by the unpleasant symptom known as "motor-biking." When the amplifier is switched on it functions for an instant and then proceeds to emit a succession of ticks or plocks at regular intervals. There may be several seconds between the ticks, or they may follow one another as rapidly as those of a watch, or again they may occur in such quick succession as to become blended into a howl. In any case, the cause is the same: owing to the high resistance of the grid leak the grid of the valve is unable to get rid of its surplus electrons. These accumulate upon it, building up an increasing negative potential which chokes the valve. When this potential is sufficient to overcome the resistance in the grid leak the charge escapes to earth, restoring the valve to a condition of equilibrium and giving rise to a plock. Actually, the value of the grid leak is not unduly critical, and a little experimenting with fixed leaks of different resistances will soon enable the constructor to determine which value gives the best degree of amplification combined with stability.

The Grid Condenser

A detailed discussion of the capacity of the grid condenser in a resistance amplifier would provide material not merely for a paragraph, but for a lengthy article. It must suffice, therefore, to mention merely one or two important points. In the first place the capacity of this condenser is not particularly critical. The great thing is that it should be large in proportion to the inter-electrode capacity of the valve which follows it. Actually satisfactory working may be obtained with a coupling condenser of any capacity between ·005 mfd. and ·25 mfd. provided that a grid leak of suitable resistance is used in combination with it. The greater the capacity of the condenser the smaller will be the best resistance value for the grid leak, and *vice versa*. My experience is that it is not advisable to use a very large capacity, partly owing to the fact that a grid leak of comparatively low resistance must be used in combination with it, thus lowering the total impedance in the anode circuit of the preceding valve, and partly because a big coupling condenser is apt to produce a troublesome form of slow ticking, since it takes an appreciable time to become charged up. Generally speaking, when a 2 megohm grid leak is used the capacity of the grid condenser should not be greater than ·01 mfd., where the following valve is one of the well known first stage note-magnifying or small power types. If experiments are made with clip-in condensers very little difference will be found when the value is reduced to ·005 mfd. Even with this small coupling capacity there is practically no suppression of the lower frequencies, corresponding to the bass notes, in a well designed resistance amplifier. Before a valve of the high amplification factor type, in which the internal capacity is usually low, a smaller condenser may be used with a grid leak of considerably greater value. The condenser may, in fact, have a capacity as small as ·0005 mfd., and the grid leak a resistance as high as 5 megohms or more. Should "motor-biking" or howling be experienced with any kind of resistance amplifier when it is first tried out, it is a good plan, before any further steps are taken, to see what effect is produced by reducing the capacity of the grid condenser. Experiments may then be made with grid leaks of different values.



This is a four valve set employing three R.C. L.F. amplifying stages.

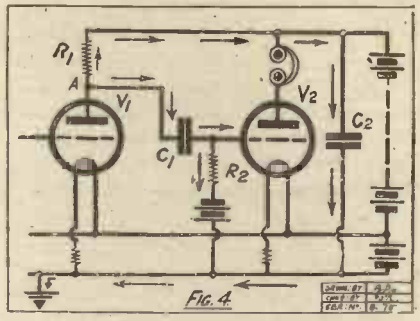


FIG. 4.

A Fading Effect

If the grid condenser is very large and the grid leak too high to suit it, "motor-biking on the grand scale" may be experienced. Instead of ticks or plocks we now have a phenomenon which may very easily be mistaken for genuine fading, the results, so far as reproduction is concerned, being very similar. When a signal is

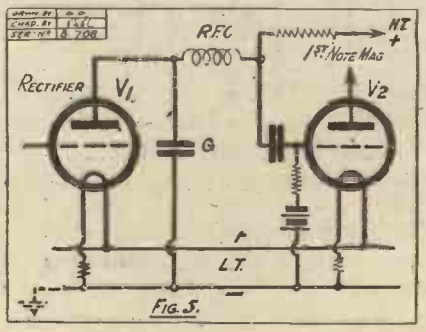


FIG. 5.

RESISTANCE CAPACITY PROBLEMS—*continued*

tuned in it comes in at normal strength, but begins almost at once to decline owing to the gradual building up of a negative charge on the grid and the slow charging up of the condenser. The falling off continues until the signal is almost inaudible; then comes a noise not unlike that caused by an atmospheric, and signal strength quickly returns to normal. I have known cases in which signal strength has taken nearly a minute to decline from maximum to minimum. One can always tell whether genuine fading is or is not responsible for fluctuations experienced by making use of a milliammeter. Should the "fading" be due to slow choking of the valves the needle will fall during the decline in signal strength to a lower and lower reading, returning rapidly to normal as the accumulated charges leak away. Genuine fading, provided that the valves are properly grid-biased, produces no movement whatever of the milliammeter needle.

Strong Reaction Effects

A resistance-coupled note-magnifier may also have a tendency to howl if the H.T. battery (particularly if it is of the dry cell type, for the resistance of dry batteries is much greater than that of accumulators) is not shunted by an adequate capacity or if L.T. — is not connected to earth. This last is an exceedingly important point, and failure to carry it out is responsible for much of the instability complained of where resistance coupling is used.

But perhaps the chief cause of instability in resistance-coupled amplifiers containing two or more stages is to be traced to the presence in the note-magnifying circuits of unwanted H.F. impulses. In the plate circuit of the rectifying valve there are two oscillating components. The greater of these is the rectified audio-frequency current, but this is accompanied by H.F. impulses which have, so to speak, leaked through the rectifier. If these find their way into the note-magnifying circuits they are liable to cause a good deal of trouble through stray reaction effects. It is therefore desirable to divert them at their source by providing a path to earth by means of a small capacity. One of the best ways of doing this is seen in Fig. 5. Here the radio-frequency choke acts as a barrier to H.F. impulses, which are thus strained out, as it were, and passed to earth through the condenser C. The capacity of this condenser will usually be quite small; a little experimenting with clip-in condensers will show the value required to give the best results. As a rule it will lie between ·0001 and ·0003 mfd. Another method is to do without the choke and to place a condenser across the anode resistance, as shown in the Fig. 3 circuit. This, however, is not so satisfactory, since a larger capacity must be used, and there is a risk of shunting away not only the unwanted frequencies, but also some of the upper audio-frequencies and thus producing a suppression of the higher musical harmonics.

A wire wound anode resistance

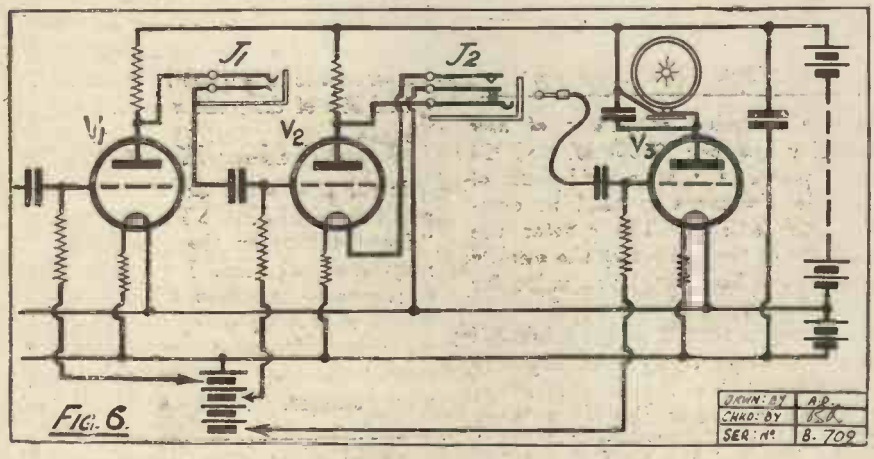


FIG. 6.

I have left till the last one of the most important of all the problems in connection with resistance-coupled note-magnifiers. This concerns the choice of the right valves in order to obtain the highest possible quality in the reproduction combined with good amplification per stage. If it were a question only of obtaining big amplification we could use throughout valves with high amplification factors, but were we to do so horrible distortion would result through overloading. Let us suppose, for example, that as an experiment we place valves with an amplification factor of 35 in each of the first two holders of the Fig. 3 circuit and a valve such as the P.M.5, which has an amplification factor of 17·5, in the last holder.

Choice of Valves

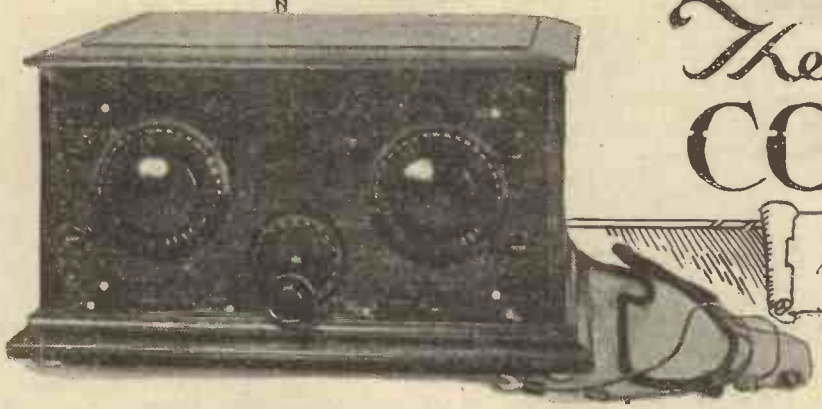
The actual amplification obtainable would be in the neighbourhood of 30 for each of the first two valves and, say, 12 for the last. The three valves therefore give a total amplification of $30 \times 30 \times 12$ or 10,800, which sounds thrilling—until we are brought down to earth by recalling that the maximum grid swing for a P.M.5 valve without overloading is about 5 volts. Since the magnification given by the first two valves is about 900, the greatest voltage swing that could be applied to the grid of V_1 is one of about ·005 volt. If we endeavour to receive with such a combination even a moderately powerful signal giving a grid swing of ·1 volt for V_1, the grid swing reaching V_3 would be some 90 volts, which is about ten times as much as even a small power valve could deal with. It is clear then that whatever else happens, a valve of the "first L.F." type is quite unsuitable in the third holder.

Grid Swing

The case of V_2 must also be considered. A valve such as the S.P.55B can deal properly with a maximum grid swing of only about 3 volts at the outside; hence the greatest voltage swing that we can apply to V_1 without overloading V_2, if V_2 is of this type, is only about ·06 volt.

If the resistance-coupled amplifier is to be used for long distance work as well as for local reception, so that strong and moderate signals are to be expected, we shall do better

(*Continued on page* 432.)



The FOUR COIL TWO

A Novel Broadcast Receiver

By H. J. BARTON-CHAPPLE, Wh. Sch., B.Sc. (Hons.), A.C.G.I. D.I.C. A.M.I.E.E.

IT has been said on many occasions that to be able to "kill two birds with one stone" is a worthy accomplishment, and certainly divers cases could be quoted to justify the truth of this remark. The point crops up repeatedly as far as home constructors are concerned, for how many times has the desire been expressed for a wireless receiver that combines both quality and quantity? Again, many seek the possession of a set which will enable the local station to be tuned in with ease, by reference to previously logged dial readings, and yet serve the additional purpose of satisfying the ambitions of those members of the household experimentally inclined.

Tone and Volume

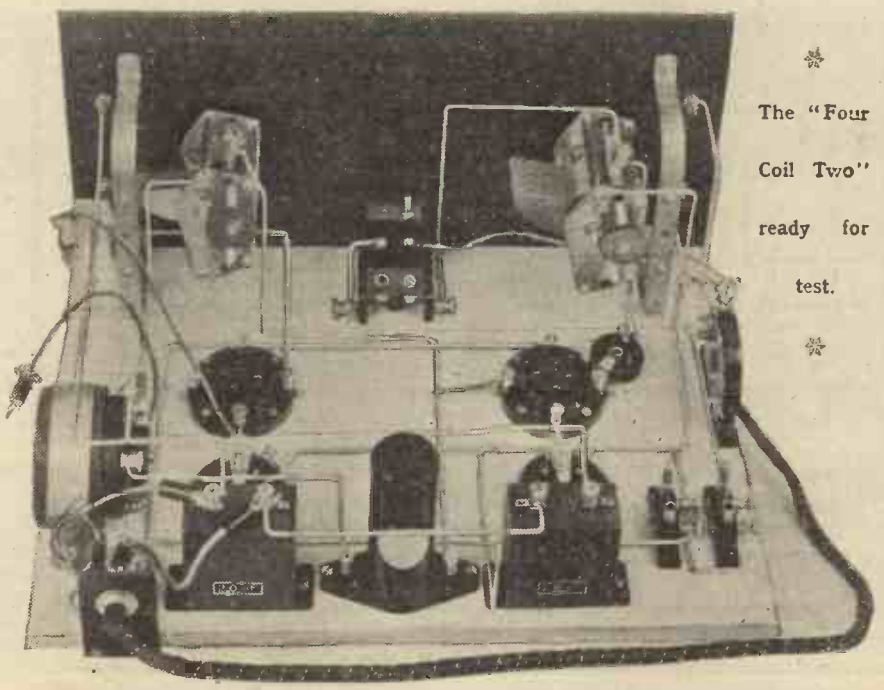
Careful experiment will prove undoubtedly that there is a certain optimum combination of inductance and capacity to give the best results from any particular receiver, when judged from the *dual* standpoint of purity of reproduction and signal strength. Unfortunately, we cannot measure quality in terms of simple units like those for current, voltage and resistance, so that in the majority of cases it resolves itself into a purely personal matter, and after all, that is the most important point of view. The time devoted to the determination of this combination is repaid in the results obtained, hence too much stress cannot be laid on this, especially for those with a critical ear for musical reproduction.

It was from considerations such as these that led me to design and construct the two valve receiver described in this article. As will be gathered from the photographs of the set, it is simple to construct, while the symmetry of the panel and baseboard lay-out gives it a particularly pleasing appearance. Instead of arranging battery terminals on an ebonite strip at the rear of the baseboard, recourse was made to a five-way battery lead which passes through a hole in an ebonite mount arranged for the filament switch, the individual leads being taken to their respective positions on the terminals of the actual components screwed to the baseboard. This gives a very neat arrangement, while the grid-bias battery is tucked away inside the set, aluminium clips holding it in position on the right-hand side of the baseboard.

In order to ascertain the effects of different valve combinations it was decided to have the filament resistances variable. Fixed resistors are admirable if a good stock of interchangeable resistances are on hand, or if the valves available are strictly limited as regards filament voltage and current. On the other hand, the appearance of two additional knobs on the panel for the filament rheostats is regarded by many constructors as an eyesore, so the happy medium has been chosen by utilising baseboard mounting rheostats.

The Circuit Chosen

It is always a particularly good plan for potential constructors to study the theoretical diagram carefully before embarking upon the construction of the receiver itself. A reference to Fig. 1 will show the scheme adopted for this set. The tuning arrangement calls for the first comment, and it will be noticed that in the actual aerial circuit we have a multiple-fixed condenser, C_1, and two coils (the usual plug-in type), L_1 and L_2, all in series.



The "Four Coil Two" ready for test.

A neat multi-flex lead is employed for connection between set and batteries.

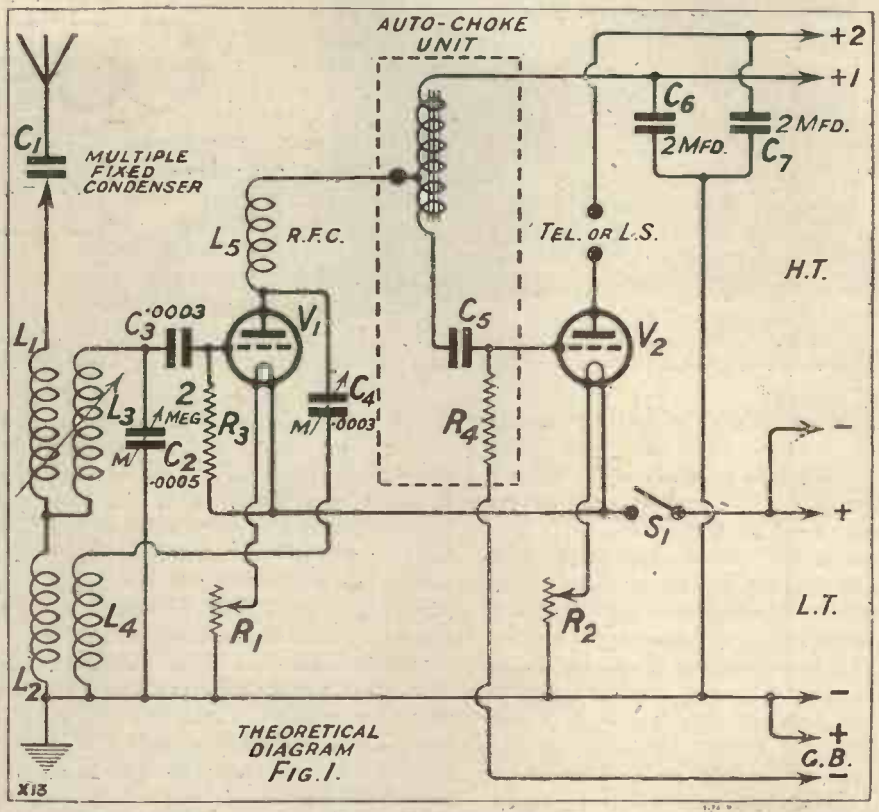
THE "FOUR-COIL TWO"—*continued*

Coupled to L_1 is another coil, L_3, one end of which is joined to the junction of L_1 and L_2. The amount of magnetic coupling between L_1 and L_3 can be altered, since these coils are mounted in a two-coil holder.

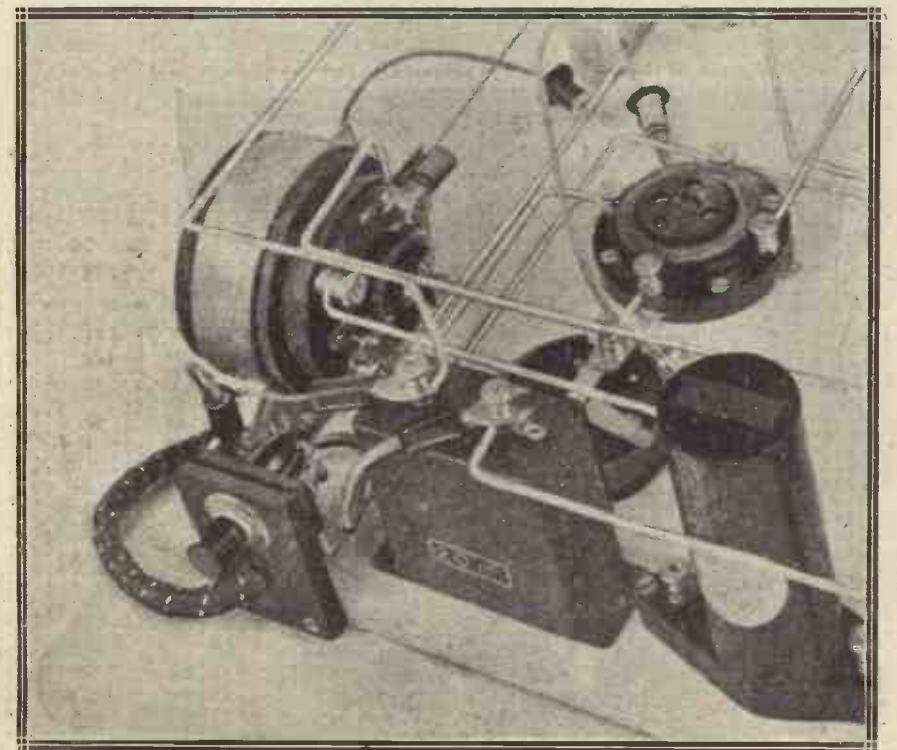
Novel Aerial Arrangement

The arrangement is thus a combination of auto and inductive coupling, which can be varied at will by the interchange of coils of various turn numbers. This gives a measure of selectivity, since we have the equivalent of a tapping on the aerial coil. In addition, by utilising a reliable geared two-way coil holder together with a dial, such as the L. & P. component employed in the actual set, a fine alteration in the coil's relative positions is made possible, while the engraved dial enables the best angular position of L_3 to be logged for future reference.

Tuning is effected by the ·0005 condenser, C_2, but since alterations of the total equivalent inductance can be brought about by the movement of L_3, it is possible to secure the optimum condition mentioned earlier in the article. Further alterations can be brought about by means of the different capacities available with C_1 so that ample scope is provided for determining the most satisfactory combination to suit individual requirements.



Reinartz reaction is introduced through the coil L_4, tightly coupled and fixed relative to L_2. As far as the coupling to the L.F. valve is concerned, the auto-choke arrangement of Watmel's was found to give admirable results. The L.F. choke, coupling condenser and leak resistance are mounted in one unit, and on test the quality of the reproduction was found to be most satisfactory.



A "close-up" of the L.F. switch panel, and the wiring to the choke unit.

Constructional Details

Any inequalities of the H.T. battery voltage tend to be smoothed out by the 2 mfd. reservoir condensers C_6 and C_7, this being noticeable particularly when the battery is reaching the end of its useful life.

Having studied the salient features of the circuit employed, we can turn our attention to details of construction. Components other than those shown, provided they are of reliable make, may be substituted for those shown without detriment to the performance of the set. Where departures are made, however, pay particular attention to any possible alterations in layout, consequent upon the different design of the substituted components.

Taking the panel first, it is advisable to mark off the positions of the holes

THE "FOUR-COIL TWO"—*continued*

for the two panel brackets, the proper alignment probably being best secured with the loose baseboard and panel in position in the cabinet. Although not absolutely essential, the employment of brackets ensures a more robust finished article, keeping the panel absolutely secure, and reducing any tendency to warp.

The positions for the holes to take the two condensers, coil holder, four terminals and four base screws, can now be marked on the back of the panel. The necessary dimensions are given in the diagram of Fig. 2, it being remembered, however, that this represents the front of panel, whereas all scribed lines are done on the back of panel. In order to prevent the front panel surface from being scratched during drilling operations, it should be protected by a sheet of thin cardboard or sheets of paper.

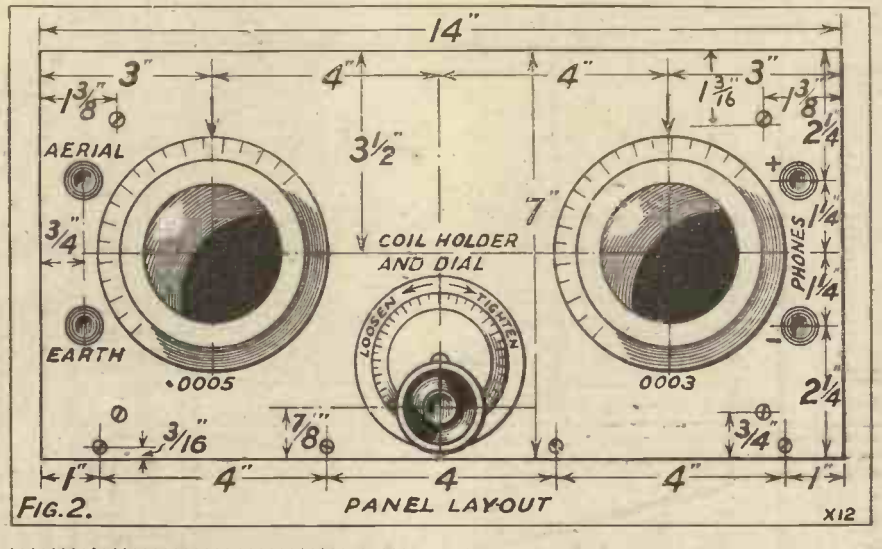


FIG. 2.

This job completed, fix the panel to the baseboard by attaching the brackets and necessary wood screws, and then proceed to mount on the panel the components indicated. In the case of the L. & P. coil holder and dial, explicit instructions are issued by the makers, so that no difficulty will be encountered. Now refer carefully to the accompanying photographs and wiring diagram (Fig. 3) in order to ascertain the positions for the baseboard components. The layout should be followed as near as possible.

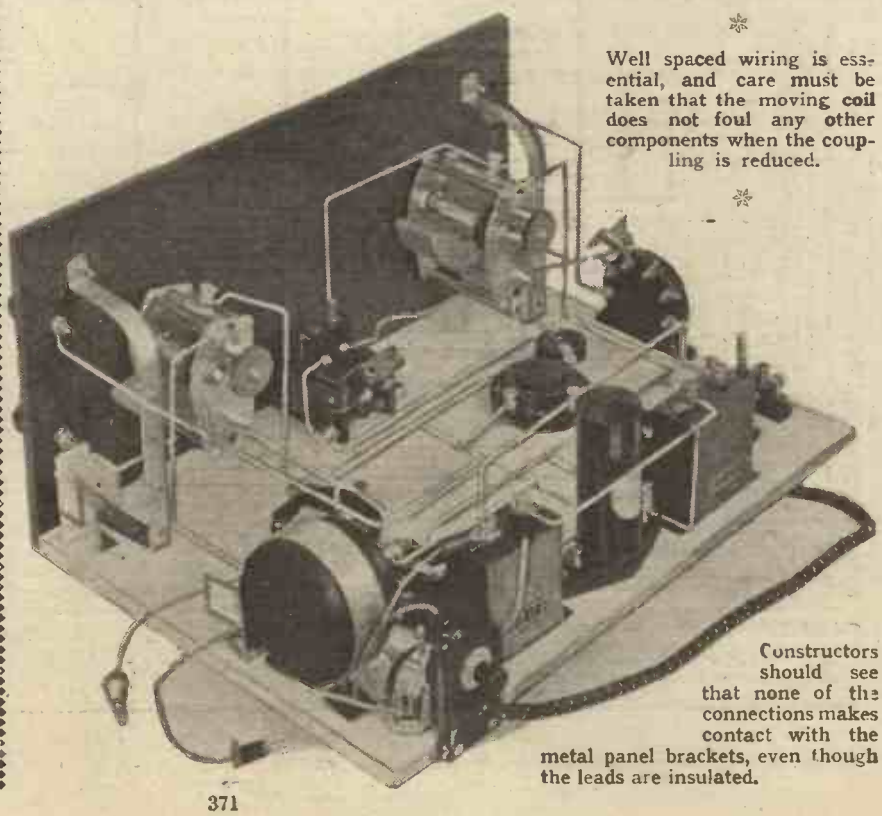
Wiring Up

It will be noticed that a symmetrical arrangement can be adopted, but the valve holders, baseboard resistors and radio-frequency choke must be screwed into position so that the largest dimensioned coil which may be placed in the moving block of the coil holder will not foul anything in its full 90 degrees movement.

The Watmel combined grid leak and condenser has been mounted direct on to the grid terminal of the first valve holder, the hole in the common pair of connecting lugs being opened slightly

COMPONENTS AND MATERIALS REQUIRED.

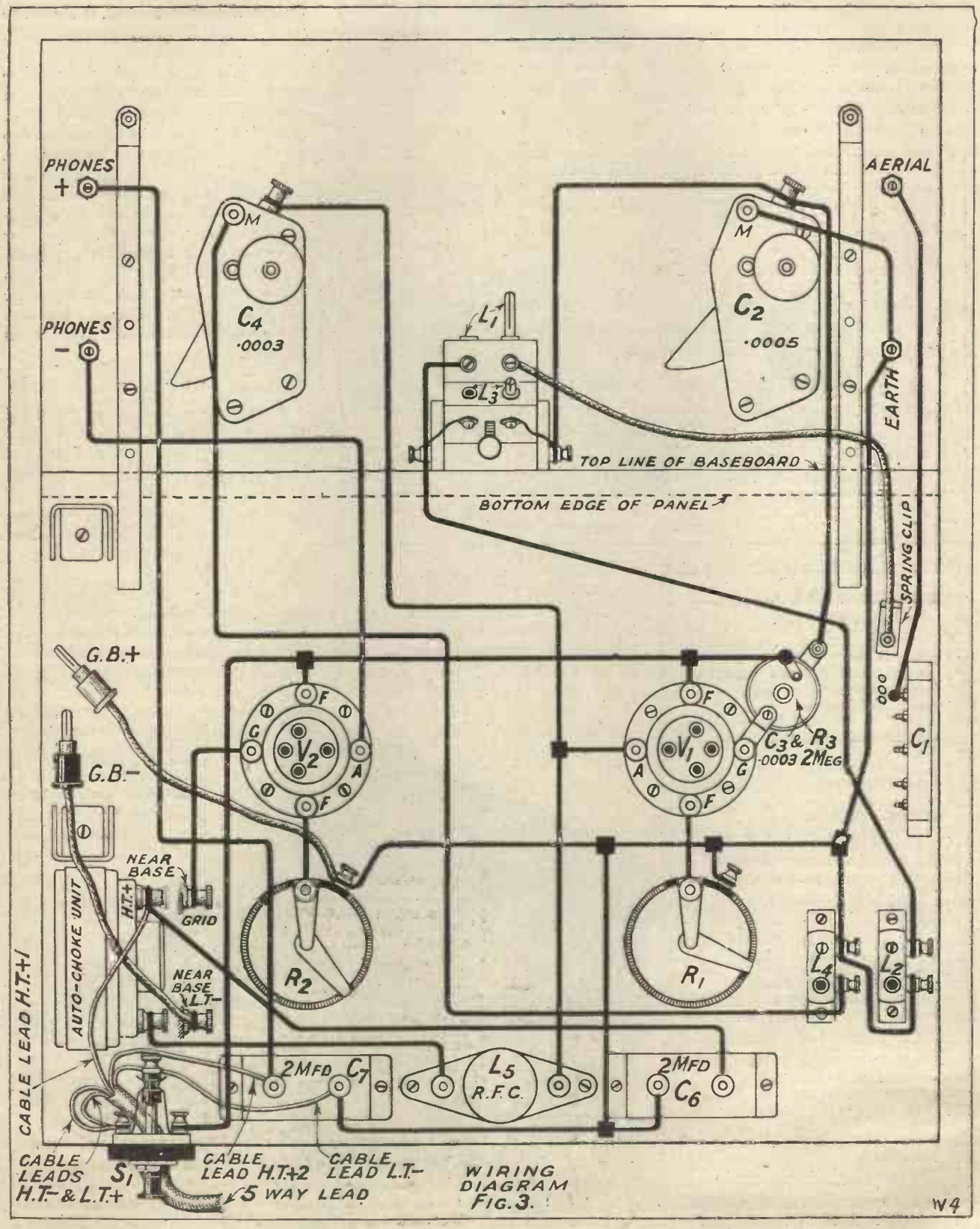
1 panel, 14 in. × 7 in. × ¼ in.
1 cabinet, taking above panel, and loose baseboard 10 in. deep.
1 Lissen H.F. choke.
1 L. and P. Universal two-coil holder (London and Provincial Radio Co., Ltd.).
1 L. and P. indicating dial.
2 Lotus valve holders, with terminals.
1 ·0005 S.L.F. slow motion variable condenser (Brandes, Ltd.).
1 ·0003 S.L.F. slow motion variable condenser (Brandes, Ltd.).
1 auto-choke, first stage (Watmel).
1 multiple fixed condenser (·0001 to ·0015). (C.A.V.).
2 baseboard rheostats (35 ohms) (Lissen, Ltd.).
Two 2 mfd. Mansbridge-type condensers.
2 L. and P. single coil holders.
1 combined ·0003 condenser and 2 megohm grid leak (Watmel).
1 pair grid bias battery clips.
1 Lewcos five-way battery lead.
1 push-pull filament switch.
4 insulated terminals engraved "aerial," "earth," "'phones," + and "'phones —" (Belling & Lee, Ltd.).
1 spring clip for C1.
2 T14 plugs and 5 indicating tabs marked H.T. + 1, H.T. + 2, H.T. —, G.B. +, and G.B. — (J. J. Eastick & Sons, Ltd.).
1 pair panel brackets.
Quantity of Glazite for wiring up, rubber-covered flex, wood screws, and 1 piece of ebonite 2 in. × 1⅜ in. × ¼ in.



Well spaced wiring is essential, and care must be taken that the moving coil does not foul any other components when the coupling is reduced.

Constructors should see that none of the connections makes contact with the metal panel brackets, even though the leads are insulated.

THE "FOUR-COIL TWO"—*continued*



THE "FOUR-COIL TWO"—*continued*

to allow this to be done. The filament switch is mounted on a small piece of ebonite drilled and filed to the dimensions shown in Fig. 4, the whole being screwed against the rear edge of the baseboard, 1 inch from the right-hand corner. Just below this switch is a

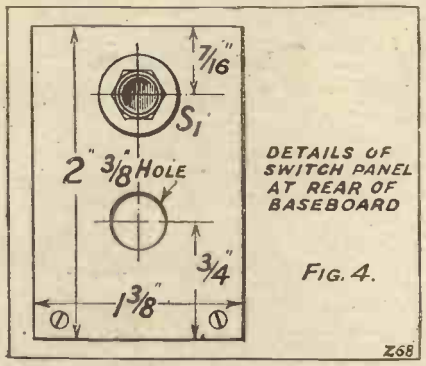


FIG. 4.

$\frac{3}{8}$ inch hole, through which passes the five-way cable lead, so that the whole scheme is particularly neat and does away with the more usual terminal arrangement.

All is now ready for wiring the receiver, and by following carefully the wiring instructions and joining the leads in the order indicated, the process will be found to present no difficulty. Of course, the wiring diagram (Fig. 3) and the accompanying photographs will be used in conjunction with the instructions. The wires in the centre of the baseboard must be kept close to the wooden surface so as not to hamper the movement of the moving coil block and coil L_3.

The Battery Lead

Frayed edges of insulation can be avoided by careful baring of the Glazite wire, while the actual wires must be kept to short straight runs wherever possible. Each wire can be soldered at its junction to the respective components if desired, but on the other hand advantage can be taken of the terminals by those constructors not keen on soldering. Make the joints quite secure under the terminal nuts, and see that they are scrupulously clean.

The five-way cable lead should be fixed to the baseboard by a small cleat just after passing through the hole in the ebonite strip. This will be a safeguard if the cables should be unduly tugged at any time, preventing strain on the individual leads and possible breaking of connections. It is necessary to remove all the spade tags in order to pass the cable through the $\frac{3}{8}$ inch hole, and before replacing them, shorten each of the leads so that they can be run to their points on the components without leaving a lot of slack wire.

The rubber cable coverings are coloured, as also are the spade and plug ends, but to be absolutely certain I advise the constructor to add indicating tabs to the wander plug ends of the H.T. leads, and also to the plug ends of the separate leads passing to the sockets of the grid-bias battery.

Testing the Set

This will militate against any errors in the outside battery connections when the set is housed in its cabinet. Remember that the neatness and efficiency of your wiring, with due regard to the little details, will reflect itself in the ultimate results you will obtain with your set, so that it pays not to hurry over this part of the work.

When completed, re-check the wiring with the wiring diagram to ensure accuracy; then the set can be placed in its cabinet. If not already done by the makers, a hole must be cut out in the back of the cabinet with a fretsaw to allow the ebonite switch mount and cable leads to pass through.

We now go on to the aerial tests. Insert the valves in their holders, testing to see that they light correctly, and then insert the H.T. plugs into the battery. The voltage on V_1 can be about 70, and that on V_2 about 100. The exact value of the grid bias will depend upon the type of L.F. valve employed, but $4\frac{1}{2}$ to 6 volts is a likely value. As to the actual valves, I have tried out many makes, a high impedance or general purpose valve occupying the position of V_1, with a low impedance valve for V_2. Amongst the most satisfactory, men-

(*Concluded on page* 442)

WIRING INSTRUCTIONS.

Join together socket of fixed coil block L_1 and socket of moving coil block L_3 thence to pin of single coil holder for L_2.

Join socket of single coil holder for L_2, to pin of single coil holder for L_4, thence to moving plates of C_2 and earth terminal, continuing to one terminal of each filament rheostat R_1 and R_2, and finally to one terminal on each condenser C_6 and C_7.

Join fixed plates of C_4 to one side of R.F.C. and to plate of V_1.

Join pin of moving coil block L_3 to fixed plates of C_3, and thence to "free" condenser lug on C_3.

Join "free" tag of R_3 to a filament terminal on V_1, thence to a filament terminal on V_2, continuing to one terminal of S_1.

Join 'phones — to plate of V_2 and 'phones + to remaining terminal on C_7.

Join moving plates of C_4 to socket of single coil holder for L_4, and join remaining terminal on R.F.C. to "plate" terminal on auto-choke unit.

Join H.T. + terminal on auto-choke unit to remaining terminal on C_6.

Join remaining terminals on R_1 and R_2 to, remaining filament terminals on V_1 and V_2.

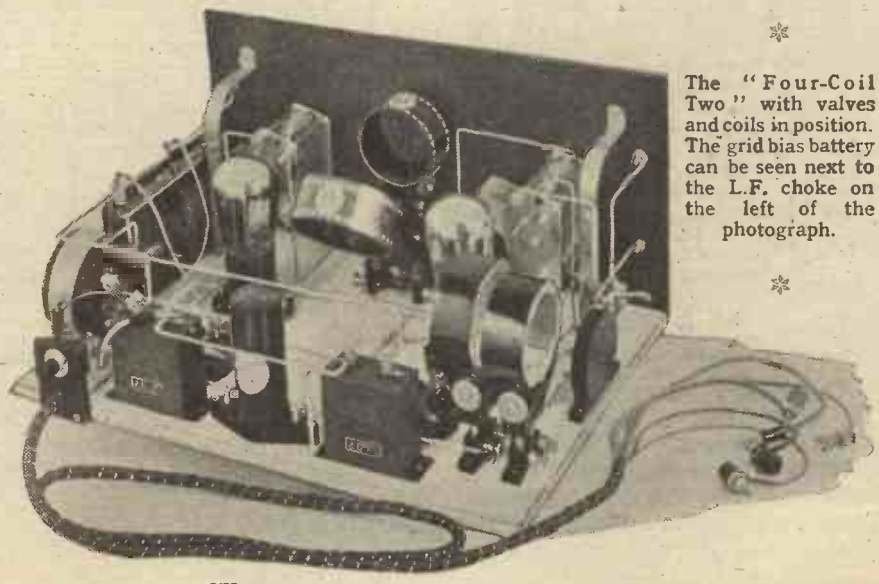
Join aerial terminal to 000 terminal on C_1.

Join grid terminal on auto-choke unit to grid of V_2.

Join pin of fixed coil block L_1 to one end of a flexible lead, the remaining end terminating on a spring clip.

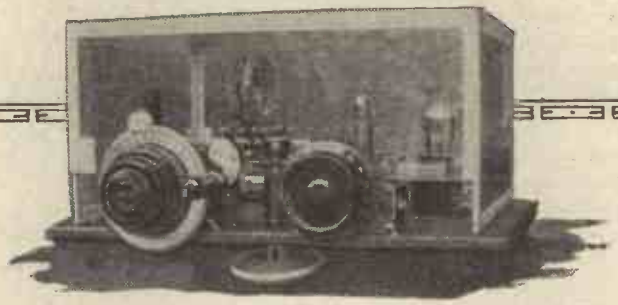
Join L.T. — terminal on auto-choke unit to one end of a flexible lead, the remaining end terminating on a plug marked G.B.

Join "earthed" terminal of R_2 to one end of a flexible lead, the remaining end terminating in a plug marked G.B.+. Leads from five-way cable should be connected thus:— L.T. + and H.T. — to remaining terminal on S_1, L.T. — to either of the common "earthed" terminals on C_6 and C_7, H.T. + 1 to H.T. + terminal on auto-choke unit and H.T. + 2 to junction of C_7 and 'phones +.



The "Four-Coil Two" with valves and coils in position. The grid bias battery can be seen next to the L.F. choke on the left of the photograph.

For the D.X. Listener



A list of all the European broadcasting stations

(Concluded from last month).

Compiled by— DUDLEY KEITH

STATIONS BETWEEN 500 AND 1050 METRES.

Wave-length.	Name of Station.	Remarks.	Wave-length.	Name of Station.	Remarks.
504	Porsgrund	Irregular.	566	Berlin (Magdeburger Platz)	Daily.
508	Brussels (Radio Belgique)	Daily, 8 p.m. onwards.	577	Vienna (Radio Wien)	Weekdays, 3.15 p.m.; Sun., 6.30 p.m.
517.2	Rosenhugel	—	577	Frieburg	Irregular.
535.7	Munich	Sun., 10.30 a.m., and most evenings.	720	Ostersund	Relays Stockholm.
545.6	Sundsvall (S A S D)	Most evenings.	760	Geneva (H B 1)	Weekdays, 7.40 p.m.
555.6	Budapest	Sun., 10 a.m. and 9 p.m.; weekdays, 4 p.m.; weather.	850	Lausanne (H B 2)	Daily, 7.5 p.m.
			940	Leningrad	Daily, 5 p.m.
			980	Warsaw	Daily, 7.30 p.m.
566	Blumendaal	Sun., 9.40 a.m., 4.40 p.m. Services.	1010	Moscow (Popoff)	—
			1050	Hilversum (H D O)	Daily, 7.50 p.m.; Sun., 11 a.m. and 1.30 p.m.

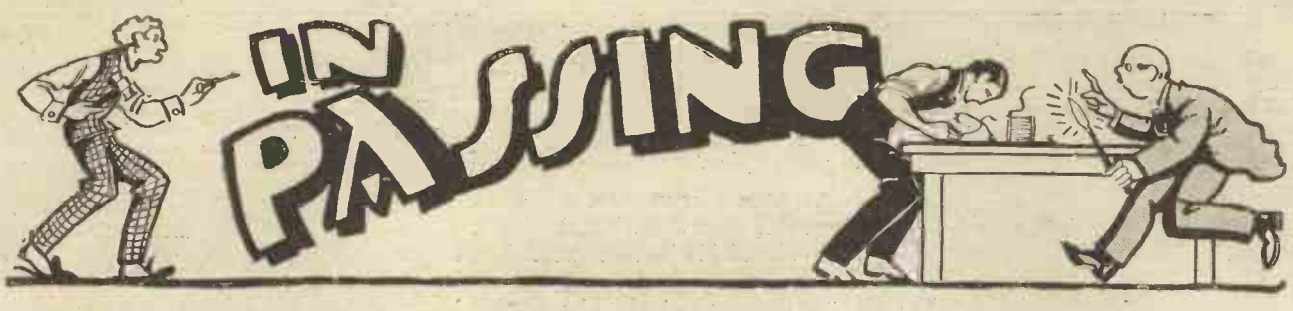
Among the identification signals, those of the following should be noted: Brussels has a high-pitched tuning note, and announces "Ah-low Ici Radio Belgique." Munich sends M U N G in Morse (— — · — — · — — ·), followed by three notes on oscillating valves, A, F sharp, D. Gong is sometimes struck in intervals. Budapest opens up with an oscillating valve, sending — · — · — ·, the dots being higher pitched than the dashes. It also has a lady announcer. Berlin (566 m.) has same signal as the other Berlin station. Vienna announces "Hallo, Hier Radio Wien Sender Welle 577"; it has a tuning signal of (· · · · — · · · ·—)V's in Morse, and closes down with S K (· · · — · —), and has an interval signal of a metronome ticking. Geneva opens with a thrice repeated whistle. Lausanne opens with chimes to indicate a tune, followed by a carillon. Hilversum announces in English and the words "Hier Hilversum, Holland."

STATIONS BETWEEN 1050 AND 4000 METRES.

Wave-length.	Name of Station.	Remarks.	Wave-length.	Name of Station.	Remarks.
1100	Debilt	Weekdays, 8.15 p.m.	1500	Riga	—
1100	Bâsle	Daily, 8.50 p.m.	1600	DAVENTRY (5 X X)	High-power station.
1110	Kbely	Daily, 6 p.m. to 7.30 p.m.	1750	Radio Paris (S F R)	Daily, 12.30 p.m., and each evening; Sun., 12.45 p.m.
1150	Soro	Relays Copenhagen.			
1150	Ryvang	Irregular			
1165	Leningrad (10kw.)		1800	Norddeich	Midnight; weather reports.
1200	Luxembourg (to be 2174)		1950	Scheveningen Haven	—
1200	Boden (S A S E)	Relays Stockholm	2000	Kovno	—
1300	Berlin (Koenigswusterhausen A F T)	Relays Voxhaus.	2525	Berlin	Intermittent news daily.
			2650	Paris Eiffel Tower (F L)	Daily, 6 p.m.
1365	Karlsborg	Irregular.	2900	Berlin Koenigswusterhausen (A F P)	—
1400	Nijni Novgorod		4000		
1450	Moscow (R D W)	—			

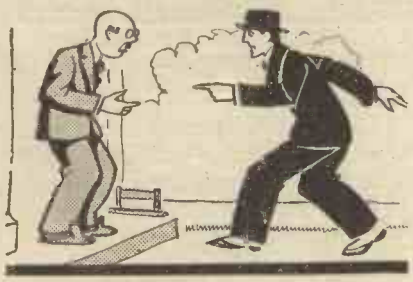
The best noted announcements for the above stations are as follow: Leningrad—opening signal, gong or chimes. Calls "Allo, Allo, Radia peredacha (phonetic), Leningrad." Moscow announces "Allo, Allo, Radia Moskva," and closes down with chimes and the pealing of the Internationale on the Kremlin carillon. Radio Paris is, of course, well known with its announcement of "Allo, Allo Ici le poste de Clixchy des emissions, Radio Paris," etc., and sounds a gong at 12.30 p.m. and 8.30 p.m. Eiffel Tower announces "Allo, Allo, Ici le poste Radio Téléphonique de la Tour Eiffel," etc., and a series of seconds counted in French.

These stations require larger aerial coils, having from 75 to 300 turns to cover the full range and can most of them be heard on two valves in this country, several being audible on the loud speaker.



LAST month, you remember, I made an attack, a little local shindy, a mere trench raid, upon Ambo's crystal set and his pa-in-law's whiskers. The set I put out of action by a cunning *ruse de guerre*, but the Twipe camouflage got away with insignificant losses, though it was palpably demoralised.

Not, mark you, that I must be understood to nurture the slightest animosity towards crystal sets. Oh, no! But this particular set was a horrid little mousetrappy thing which hopped about the table if one tuned in to a really strong station. Briefly, it was



. . . I hastened to the scene and Ambo opened the door. . . .

the kind of set which is sold in bits, on a large card bearing pictures printed in poisonous colours and depicting a happy family (with wooden faces, too much hair, and out-of-date clothes) listening to a loud speaker shaped like an early model phonograph horn. Hence I rent it in twain and Ambo hove it out of the window. The dog buried it next day, with every mark of respect, in company with a very fruity mutton bone. R.I.P.

As to Ambo's father-in-law—well, he must have had some great sorrow in his younger days to have let the weeds grow so profusely over the grave of his manly beauty. His whiskery was simply immense—a perfect Bird Sanctuary. Quite impossible for him to do fine soldering or drilling; his face-mat would have stopped the works of a steam-roller. In fact I was told that he had been forbidden to use the Tower Bridge because he had once entangled the bascules, and as a result, six steamers lost high water and the mails were delayed.

I got a postcard from Ambo, which read:

"Can you drop in? Urgent."

"My Aunt!" I thought. "Twipe must have caught his chin-crop in the mangle," and I hastened to the scene.

"Teese All Thmassed"

Ambo opened the door. What a shock I received! He looked about as cheerful as a pelican with a couple of carraway seeds for dinner, and his cheeks were sunken like those of a centenarian.

"My dear Ambo," I cried in sympathetic tones, "what on earth—— You don't mean to say that pair of cuckoos have tried to nest in Mr. Twipe's beard? Why, it was only last week we drove the swallows out. Really, we shall have to——"

"Thass all right," he replied. "I don't care shixpench about the birdth. I've losh me teese. Sneezed 'em into a sack of potatoesh. Horsh took fright and ran ash far ash Whitehall before he wash shtopped. Teese all thmassed. Awful nuishance!"

"Well," I answered, "what's the real trouble? Urgent, you said."

"A Piteous Sight"!

"Yesh. Fact ish—I shee the B.B. Shee is going to give a talk zish munse about potatoesh. 'The Tuber and Its Enemish," by the Minishtry of Hellsh. I want to hear that, and I thought you might help me make up a wirelish shet in time. Can you?"

"My boy! Delighted. But we must have Mr. Twipe to help us. And Mr. Puddle, too."

"Yesh, you mean Guddle."

"Do I? I forgot! Very well, then, let's ascend to the 'den' and begin operations. How's Asia?"

"Asia is—— Sank goodness! Heresh my spare teese come. *Clip clop.* Ah, old sport, that's better! Now I can talk. Man without his teeth is like a woman without a tongue. Handicapped!"

So we went upstairs and contemplated the collection of wireless apparatus Ambo had made. It reminded me of those Government dumps one used to visit just after the war. A piteous sight! Good stuff going not only to wrack but also to red ruin. Twipe sneaked in, looking like a walking mop, and then I made my great resolution. Twipe should sleep that night with a raw face, and not tear the sheets any more.

"Have you got any soldering things?" I said in a sergeant-like tone.

At the word Mr. Twipe emitted a series of beard-waves and passed from the room with something of the easy and uncanny alacrity of the Disappearing Lady.

"Preparing a Good Alibi"

"Gymnastic old creature," I remarked. "Flits here and there, in and out, like a butterfly. What is he up to now?"

"I think he has gone for the soldering things," said Ambo. "The plumber left them in the cellar last winter while he went for a sack. He never came back, so I expect he got it. There's a bottle of spirits of salt, some resin, a lump of what-is-it, a can of solder and a soldering-bolt like a sledge-hammer."

"Capital!" I chuckled, rubbing my hands in high glee. "Not exactly the outfit for fine panel work, but the very thing for rendering the starving homeless. Ambo, old fellow, to-

. . . When the brew really began to smell Mr. Twipe could hardly restrain himself. . . .

night's the night! Yon moon shall go down upon the Hairless Wonder. No more shall the laundry be blamed for tearing your household linen. Shaven and stark shall he lie, his rosy chin looking like the last peach on the wall. Then——"

IN PASSING—*continued*

"But surely you won't—er—do the old bloke any harm, y'know," said Ambo nervously.

"He shall do it himself, lad," I replied. "I'll not touch him. I've a genius for coming out of an affair looking all the more innocent the more I am guilty. No! it shall be quite accidental. Ha! here's Mr. Twipe! That's fine, sir! You going to help us? Why, excellent! But I think perhaps you had better not. You absolutely insist? Very sporting, sir! But I don't think it would be quite the thing. Better sit and watch us. There! That's right." I sat him down in his usual corner. Nothing like preparing a good alibi.

"The Amateur's Chief Delight"

"Well, Ambo," I said, "let's get on. Solder looks a bit fierce, doesn't it? We'll have to purify it, I'm afraid. Got any pigeon's milk? No? Hum! that's a pity. Nothing like it for taking the dephlogisticated air out of solder. Ah, well, we shall just have to do our best."

I got a lot of solder on a large flat iron tray over a gas-ring, smothered it with resin and candle-grease and began to fry this worse than infernal mixture. Ambo was in the seventh heaven of enthusiasm, stirring and taking notes while I explained how it is that soldering is the amateur's chief delight and standby.

"A good joint," I said, "is the trade mark of a M.I.R.E., just as much as of a Master Cleaver."

When the brew really began to smell Mr. Twipe could hardly restrain

. . . all irrevocably attached to Mr. Twipe's radiator-muff. . . .

himself and I had to push him back into his chair every few minutes.

"You see all that rising to the top?" I said, holding Ambo well over hell's cauldron. "That's what we want to get rid of." That was a true word spoken in earnest, goodness knows.

"Um! Yes, I see," snuffled Ambo. "But the—er—the smell is not unlike a fertilizer factory on fire. I distinctly remember when Jubbs' Choice Manure and Wormicide Works were burnt down. The——"

"I daresay. And 'Mrs. Parker' was a bad crop that year. Really, Ambo, this potato biz is the limit. It poisons human intercourse and pollutes the wells of polite conversation. Cut it out and have another stir."

At last the solder became fluid; a fine panful.

"Now for the critical moment," I said, at which Mr. Twipe edged his way in and stood gloating over the awful scene.

"This is rather a delicate operation," I explained. "It needs the three of us. First, let me rig up the ogzimeter."

On the far side of the sizzling pan I put a spectroscope which I had dug out of Ambo's collection. I placed a lighted candle behind it. To gaze through the spectroscope one had to put one's chin over the pan.

"Doom of the Twipe Forest"

"Now then, Mr. Twipe, you are to be entrusted with the most scientific job of all. I want you to stand here, in front of this ogzimeter, and when I say, 'There she blows,' you will bob down and look through the ogzimeter and shout 'Upsey-daisy' when the light goes out. Please don't make any mistake, or I shall regret having put you in the place of honour. Ambo, you turn out the gas-ring when I call. Now—are we ready?

Old Twipe gripped the table, a hand on either side of the pan, and straddled out his legs like a giraffe at a water-pool. Ambo seized the gas-tap and prepared to co-operate, but I observed in his eye the fear of the unknown. After all, to play fast and loose with half a century's growth on the chin of a wife's father calls for dare-devilry far beyond the dreams of medical students.

The hour struck and the doom of the Twipe-forest cracked.

"*There she blows!*" I hissed.

Down bobbed Twipe, like a good scout. He glared through the spectroscope like a butler through a keyhole; concentrated; oblivious to the roar and fret of the great world without; breathing hard.

Beautiful! His whiskers were well down in the melted solder.

"'Full fathom five thy father lies,'" I hummed merrily, and "out with the gas, Ambo," I said.

I couldn't resist giving the frying-pan a few gentle rocks, like a photographer with his developing dish. Nothing like making sure of a job, and the solder was beginning to harden.

Then I pinched out the candle.

"*Upsey-daisy!*" bawled old Twipe as the light went out. And, by the Great Green Grid of the Little Yellow

. . . China appeared to be inhabited by bottles. . . .

Valve! the daisies *did* come up. So did the solder and the pan and the grease and resin—all irrevocably attached to Mr. Twipe's radiator-muff.

Ambo groaned and covered his eyes with his hands.

"My *dear* Mr. Twipe!" I cried in anguished tones. "What *have* you done? I wanted you to keep out. I begged you not to come too close, didn't I?"

"I'll bear you out in that, laddie," came from that noble fellow Ambo, who was biting on the ogzimeter in agony.

"Bring me a Barber"!

But Twipe! Well, he stood speechless and purple with rage. Luckily, he couldn't say anything because the weight of the solder and the pan kept his lower jaw down. Sympathetically I pressed the pan into his hand and showed him how, if he held it up in front of his face, he could shut his mouth. At this moment Mrs. Ambo popped her head round the door and sniffed.

"What's dad doing, Julian?" she enquired.

"Only just looking to see if any hairs have got into the solder, Mrs. Ambo," I answered with a smile.

"Oh, well, I'm afraid he won't see many because his spectacles are downstairs."

(*Continued on page* 434.)

The "COMBINE" FIVE ON TEST.

In this short article Mr. Harris gives his experiences with the "Combine" Five receiver described in last month's Modern Wireless

By PERCY W. HARRIS, M.I.R.E.
(*Editor—"The Wireless Constructor"*)

HOWEVER much time and thought one has given to the design of a wireless receiver the actual results likely to be given are often a matter of speculation. In the case of the "Combine" Five where much care has been devoted to the design, the results obtainable with it were likely to be of more than ordinary interest. Accordingly, when the set was brought to my laboratory I lost no time in joining it up and ascertaining for myself just how far pre-conceived ideas would be verified.

The first impression gathered from the "Combine" Five was of an extremely selective receiver, the sharpness of tuning being really phenomenal. Owing to the fact that separate fixed resistors are not used, neutralising cannot be carried out quite so simply as with some other sets, and I found it useful in this receiver, as in others with which I have been experimenting recently, to add a little additional capacity between grid and plate of each of the H.F. valves so as to bring the neutralising point well within the scale of the neutralising condensers. This addition is not strictly necessary and the set works well without it, but it is so simply made that many readers may care to try the idea themselves.

Minor Improvements

Two pieces of insulated wire (such as Glazite) are connected to the grid and the plate terminals of the valve holders and twisted together, care being taken that the further ends do not touch each other. A length of about three or four inches for each piece is quite sufficient. The twisted wires and the insulation between them form a small condenser so that this capacity, as well as that of the valve itself, must be neutralised. This scheme is useful in all neutralised sets where the amount of capacity necessary to balance is very small, as is the case with the present receiver.

With some valves, too, I found it better to disconnect the wires joining the earth screens to one another, and to earth. The amount of hand capacity introduced by removing these wires is not great, and I found that the set neutralised better without this connection.

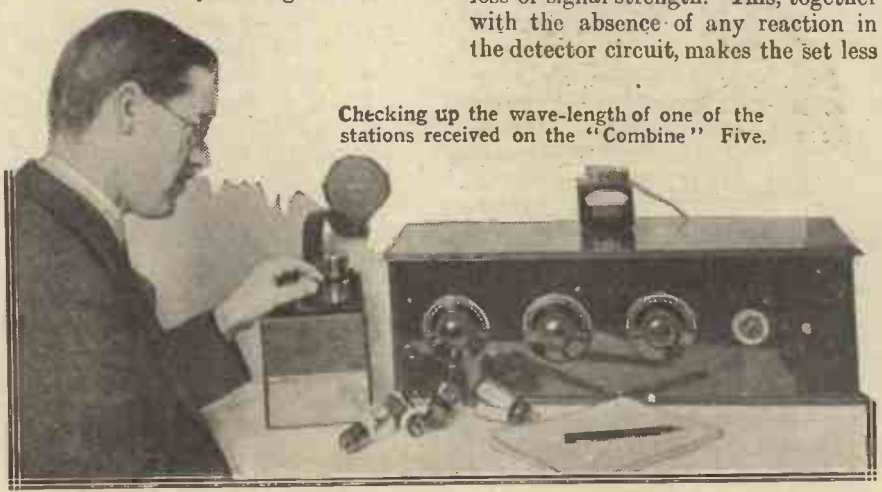
So far as results are concerned, the following stations were tuned in by Mr. Kendall and myself in my laboratory. As suggested by Mr. Allinson in his article on the design of the H.F. side, additional sensitivity is obtained in the set by keeping the neutralising condensers "off-balance." The stations given below were tuned in in this way, and entirely on the loud speaker. The strength of reproduction varied from "weak loud speaker" to "full loud speaker" and, of course, all were obtained while London was working, without interference from that station.

Langenberg	Toulouse
Dortmund	Stuttgart
German Relays	Glasgow
Belfast	Bournemouth
Dublin	Hamburg
Breslau	Rosenhugel
Birmingham	Munich
Madrid	Malmo
Cardiff	Newcastle
London	Brussels

These stations are not given alphabetically, but in the order in which they were picked up, Mr. Kendall noting down the names as I tuned them in. The period occupied in tuning in these stations was about an hour, and it was obvious that other stations could be found by continuing the search. It was considered better to give the reader a list of stations obtained in a specified period, rather than a long list of stations received, some on one night and some on another—a method which might conceivably give a false impression.

Pure Reproduction

As to the general sensitivity of the set, it should be pointed out that the very sharp tuning which Mr. Allinson apparently had in mind in designing his section, is achieved by very loose coupling, for which one pays in some loss of signal strength. This, together with the absence of any reaction in the detector circuit, makes the set less



Checking up the wave-length of one of the stations received on the "Combine" Five.

THE "COMBINE" FIVE ON TEST

—concluded

sensitive than is possible with five valves. On the other hand, the absence of reaction and the fairly loose coupling of the H.F. stages give us sharpness of tuning and a purity of reproduction which are both highly desirable advantages.

Many Valves Suitable

The set was then tried with several different makes of coils, and worked equally well with all of them. Changes of aerial tapping were rarely made, one tapping serving for a very wide band of wave-lengths. In the wave-length range, the lower limit is about 260 metres when used on my aerial and the upper just about 600 metres. Owing to the effect of the aerial the first condenser only reads roughly the same figures as the second, while the detector circuit condenser gives more widely different readings from the others. For this reason, and as the set is exceedingly sharp in tuning, the reader may find difficulty in tuning any station other than his local one at the first trial. It is therefore advisable to prepare a chart and carefully note down the readings for each station as it is picked up. Once a few of these figures have been noted it will be easy to find the stations again, as well as any others near to them.

A number of different makes of valves were tried in the set, and so far as the H.F. side was concerned, all of the types of valves having characteristics similar to those mentioned in the booklet, gave satisfactory results, including the new Cossor 6-volt H.F. valves, which seemed to suit the transformers very well. Similarly, tests with the valves mentioned for the detector and the L.F. side were also quite satisfactory. Here, again, the new 6-volt Cossors were tried with good effect. These are mentioned here as they were not available when the original booklet was prepared, and were therefore omitted.

One and a half volts grid bias seemed to suit the detector, and the position of the detector rheostat was not at all critical. Naturally, the local station could not be tuned in fully, as this brought about gross overloading of the receiver. When detuned to bring the strength down to a reasonable value for a living-room, the quality was admirable as would be expected from the L.F. portion of the set. As for the detector excellent results were obtained with the ordinary H.F. valve having an impedance of round-about 20,000 ohms, and an amplification factor of 20. This is mentioned, as those readers who have such valves on hand, may care to try them in this position. Greater volume is obtainable, however, by using the newer valves of higher amplification factor, such as those mentioned in the original article. Similarly, an ordinary small power-valve can be used in the last stage, provided full volume at loud speaker strength is not required. There is no question that, even for living-room strength, a super power-valve gives definitely better results than the ordinary power valve, although, of course, its H.T. current consumption is greater.

I have been asked by various readers as to the ratio of the "output" transformer to be used in the "Combine" Five, and I would take this opportunity of explaining the point. If your loud speaker is a high-resistance instrument (say, 2,000 or 4,000 ohms) you require a "one to one" transformer, whereas for a low-resistance loud speaker you will need a step-down transformer, usually a "ten to one" ratio.

The studio control room of one of the Berlin broadcasting stations.

DIRTY ACCUMULATOR CASES

AFTER much use and carrying about from place to place, the exteriors of celluloid accumulator cases generally get into a very dirty and stained condition, so much so that it is often a very difficult matter to observe the condition of the plates through the discoloured case.

A very useful liquid for cleaning the exterior of an accumulator case of the celluloid or composition variety is *glacial* acetic acid. This is a commodity a small quantity of which can be purchased very cheaply at any druggist's shop. Half an ounce of the liquid will be found quite sufficient to treat several accumulators with, and any of the liquid remaining over will keep in good condition for an indefinite time if it is retained in a corked bottle.

A Simple Method

A small rag should be just saturated with the acid, and then rubbed over the outside of the dirty accumulator case.

This method of cleaning will quickly result in the case being rendered reasonably transparent. If, however, the accumulator case is exceptionally dirty and discoloured, a repeated application of the acid-moistened rag, after a day or two's interval, will effect the removal of the dirt and discolouration.

After carrying out the above treatment, always be sure to wipe the sides of the accumulator case over with a wet rag in order to remove all traces of the acid. The acid itself is not detrimental to the celluloid case of the accumulator, but any traces of it remaining on the case might find their way on to the surface of some other article such as a tablecloth, or covering with which the accumulator might subsequently come in contact.

A well-known ·66 Amp. valve, the DE 3.

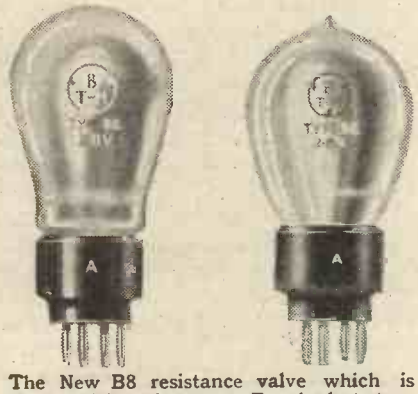
MORE ABOUT YOUR VALVES

New valves are still coming out, and the question "What valve shall I use?" is everyday becoming more difficult to answer. The following notes will be of value to every constructor.

By K. D. ROGERS,
(*Assistant Technical Editor "Popular Wireless."*)

The B5, another famous low consumption dull emitter.

I WAS remarking last month that it was a difficult task for the constructor to keep *au fait* with all the valves that appeared on the market, and since then several new ones have been brought to my notice. Among these I must mention the B8 and ST21A, two 2-volt resistance-capacity valves, though they differ largely in characteristics.



The New B8 resistance valve which is discussed in this page. For the last stage of amplification the B6 is advised by the makers.

The former has a high *mu* of 50, but this is unfortunately accompanied (in my opinion, at any rate) by a high impedance, the figure being about 180,000 ohms. These figures give a fairly steep curve with an extremely low H.T. current consumption, the value at about 100 volts being 20 microamps when the grid bias is set so that the valve is operating on the centre of the straight portion of its curve. The makers advise a 2 to 5 megohm anode resistance and suggest circuits which give an anode bend or grid leak detector using the B8 valve followed by another B8 as resistance amplifier.

The B8 valve works quite well in the circuits recommended by the makers, but I cannot say I like the tone produced. It seems rather difficult to avoid overloading the last valve even if a super-power valve be used. The B6, as advised on the leaflet enclosed in each valve carton, does not seem capable of dealing with the voltage swing when the set is operated within 20 miles of the local station. Especially, of course, is this so when Fig. 2 (grid leak det.) on the leaflet is being used.

I would advise those who use the B8 to use it in the first stage only and to have a valve with less *mu* and a lower resistance in its anode circuit in the second, finishing up with a super-power valve if they desire really pure reproduction. This latter phrase may be open to criticism as different minds think differently upon the subject of "pure reproduction." I can but give my ideas on the subject.

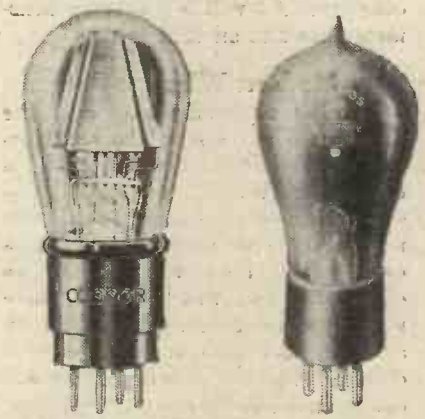
Further Points

Another point I suggest, and that is that some form of H.F. damping device or choke be used in each circuit and in both cases an H.F. by-pass from plate or reaction coil to *earth* be adopted instead of the method shown in one, and omitted altogether in the other.

I have always found that where lower anode bend rectification in such a circuit as the first is attempted, quite a great deal of H.F. amplification will occur and be passed on to the next valve. Especially will this be the case if no choking arrangement or even by-pass is provided in the circuit employed. On long wavelengths such as those employed for Daventry and Radio Paris, the H.F. component may assume awkward proportions and I am afraid that unless special precautions are taken in the way of choking systems quite serious distortion may often occur. I must confess that the amplification is very satisfactory with B8 valves, but there seems to be an unnecessary suppression of the lower frequencies which is rather disconcerting at times. Constructors should make a point of hearing a set using these valves and judging for themselves, for, as I remarked before, opinions differ and what I may not consider good reproduction may be very pleasing to another's ear.

Another point that surprises me is the filament rating of the B8, which is from 1·8 to 2·8 volts. Why this peculiar range of voltage was decided upon (I suppose it was to come in line with the B5, B6, etc.) is not clear, as the makers' state that the voltage may be lowered to 1·8 volts without "any marked falling off of results being noticed." Personally, I think the valve would have been greatly improved by making it either a 1·6–2·0 volt valve or giving it a filament really suitable for a 4-volt accumulator and not a cross between the two.

The ST21A is of a different type, being a valve for operation from a 2-volt battery and having an *mu* of about 35 with an impedance of



Two valves suitable for use in the "Black Prince." The Cossor H.F. (left); and the Cosmos SP55R for last stage working. Both are 6-volters.

70,000 or so. It should prove very satisfactory as an L.F. resistance amplifier or anode bend detector when a suitable circuit is in use.

I have, since last month, thoroughly tested the new Cossor 6-volt range, and find all the four valves extremely satisfactory. The R.C. valve is not

MORE ABOUT YOUR VALVES—*concluded*

perhaps quite as good as others I have had, but it is very good and can be thoroughly recommended. The H.F. valve works well in most H.F. circuits, especially neutrodyned ones, and also as a second L.F. amplifier with resistance coupling. The L.F. valve is

Constructors of the "Four Coil Two" will find valves of the type shown here quite satisfactory if 2-volters are required.

an excellent amplifier and the Stentor Six is certainly the "goods" where a super-power valve is desired.

The Six-Sixty people (Electron, Ltd.) have also added to their range by the addition of the SS7A, a 4-volt super-power, the SS11A, a 6-volt super-power, SS12 for H., D. or L work, and the SS13 for resistance coupling. All valves give very satisfactory results on test.

Modern Wireless Sets

Now let us briefly look over the three main valve sets, the construction of which is described in this issue of MODERN WIRELESS. The 4-valve set by Mr. Percy Harris will need careful matching of valves if maximum quality and sensitivity are to be obtained. You will, as usual, have to compromise somewhat between an absolute maximum of either quality of sensitivity, but in so doing you will obtain an excellent receiver, capable of really good reproduction and range of reception.

The first valve must be suitable for H.F. work, and I would suggest a valve having an impedance between 20,000 and 40,000, the new Cossor 610H should be very satisfactory here, or any other valve with similar characteristics.

The detector can be of the same sort or one of the new high resistance valves.

For the first L.F. amplifier you could use the same valve as for H.F. or one of the high *mu* valves such as the 610 RC., ST61A, Mullard PM5B, if 6-volt valves are being considered, or valves with similar characteristics if 4 or 2-volters are to be used. Be careful about the grid bias adjustment and see that you arrange the H.T. so that the valve does not distort owing to its being overloaded. As a matter of fact, on local reception I expect the high *mu* valve *will* be overloaded and a valve of the same characteristics as the first will be preferable. Personally, I should sacrifice a little sensitivity here and use a 20,000 ohm 20 amplification factor valve and be sure of good reproduction.

The last valve can be a power or super-power, as required. If really high amplification is being obtained by the first three valves, an ordinary power valve, even when properly biased, may not be capable of dealing with it, and so a super-power is safer, if you can afford the extra drain on the H.T. battery.

The "Overseas" Three

The Overseas Three is quite a straightforward receiver, employing a neutrodyned H.F. stage, detector with grid leak and condenser, and Reinartz reaction and a transformer coupled note mag. Thus there is no need to go deeply into the valve question: probably two moderately high amplification factor valves will be best for the H.F. and det. stages—about 20-30 would be a convenient figure—and a power or super-power for the last stage. These last stages need a fairly low impedance valve as a rule because the impedance of the average loud speaker at speech frequency is not too high, and so I should always keep below 8,000 ohms. Often a valve below 5,000 is preferable, while, if a cone loud speaker is to be used, 4,000 ohms is usually as high as one can safely go. I am assuming, of course, that the speaker is being used direct in the plate circuit of the valve and that no output transformer or choke system are being employed.

* * *

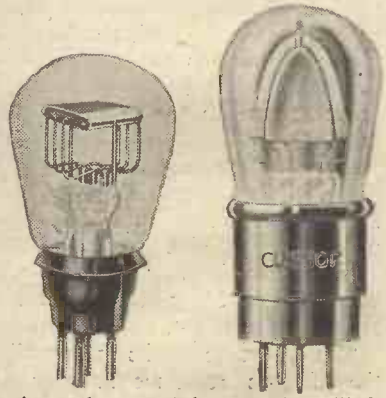
The valves best suited for the "Four-Coil Two" are, of course, a moderately high *mu* detector and a power valve for the L.F. stage. The choice will not be at all critical and many good valves will be found among the 2, 4 or 6-volt class. Keep the detector of a fairly high impedance, not less than 20,000, I should say.

General Purpose Valves

The possessors of general purpose valves need not think by the foregoing that these circuits essentially require the various types of valves mentioned; these are merely given as a guide for those who desire optimum results regardless of the type of valve necessary.

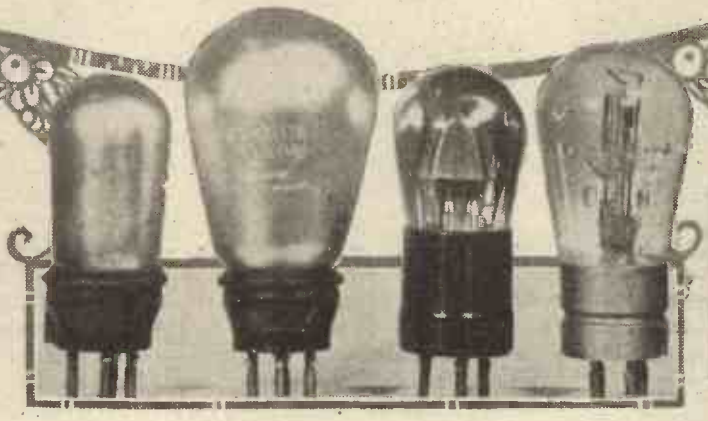
Such valves as the B4 or DE5, old friends of a great number of radio enthusiasts, can be used successfully in most circuits—except where resistance coupling is employed—and in the last two sets mentioned on this page similar valves would give the constructor a good idea as to how the sets worked, if he is out to try the various circuits and does not want to expend more money than is absolutely necessary.

From this it will be seen that, although I consider the term misleading, "general purpose" valves have a great many uses, and if they are good ones, are deservedly popular. Maximum efficiency from one valve in *all* circuits cannot be expected, of course, and so the letters "G.P." must not be misconstrued as meaning "full efficiency in all positions," they merely indicate "usable with satisfactory results in all positions," and, as such, the B4, DE5, various R valves, in fact any valves with impedances between 5,000 and 10,000 ohms and moderate magnification factors—are all reliable "stand-by" valves for the man who wants to try out circuits, but who can only afford a few valves.



Seekers after 2-volt last stagers will find these two valves extremely useful. They are (left) the Marconi DEP215, and (right) the Cossor Stentor Two.

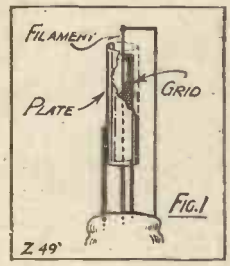
The Ethics of Filament Design



An article of interest to all users of valve receivers.

By H. E. HASSELL

WITH the large number of valves at present on the market of all sizes and types, one hears a great deal about various designs of filaments. Certain types employ one system while others utilise a totally different method, and there are probably very few members of the average public who have any very clear ideas upon what is desirable in a filament in order to obtain the best results.



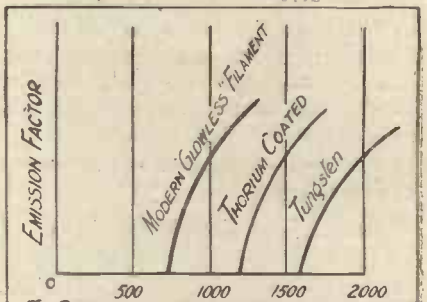
The simplest method of arranging valve electrodes.

Wasteful Filaments

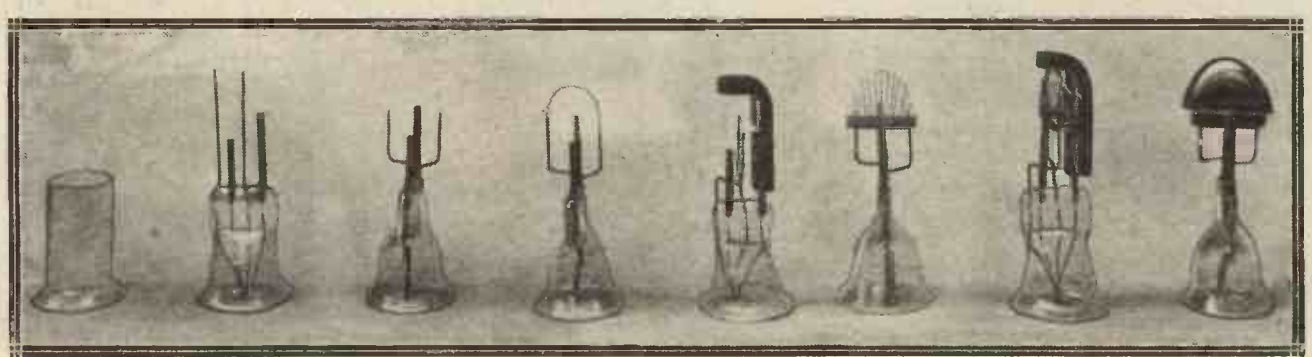
Let us consider the electrical characteristics first of all. In the old days we had short, comparatively thick, filaments of tungsten, which were heated by an accumulator to incandescence. At white heat the tungsten filament gave off electrons, and this emission was utilised in the usual manner, being attracted to an adjacent anode kept positively charged for the purpose by an H.T. battery, and the flow of electrons being controlled by a third electrode or grid placed in between the filament and the anode.

It was not long before scientists realised the enormous inefficiency of such a device. The valve would handle and amplify successfully powers of the order of a micro-watt only, whereas the filament itself took 3 or 4 watts continuously from the accumulator in order to maintain it in the state of incandescence necessary to the production of the electron emission. The cry then went up for efficient filaments, so that the watts consumed by the filament should be reduced to a more reasonable figure, and to-day the filament consumption is usually only a fraction of a watt.

The original types of bright emitter filament were, as a rule, short and thick, and apart from their heavy consumption of current, they suffered from two disadvantages. In the first place, the centre of the filament was very hot, while the ends of the filament, which were only a short distance away, were practically cold. This meant a great deal of useless heat dissipation, requiring an expenditure of energy which was not converted into electrons, and it will be clear that this *end cooling* would be a large source of inefficiency.



From this point of view, therefore, a short filament is bad, and if some means can be found of increasing the length of the filament, then the



Steps in the construction of a well-known valve whose filament strength is of a very high order.

THE ETHICS OF FILAMENT DESIGN—*concluded*

effect of the cooling at the ends of the filament will be relatively much less serious. There is, however, another and even more important argument in favour of the long filament, and that is that the emission obtained for a given current depends essentially upon the length of the filament, which is the primary source of the electrons. For a simple valve having a cylindrical anode of radius r cms. with a concentric filament of the type shown in Fig. 1, the emission current is given by the expression

$$i = \frac{14{\cdot}69}{r} v\ 3/2 \text{ micro-amps per cm.}$$

length where v is the anode voltage. For a given size of filament, therefore, and given anode voltage, the emission current increases directly as the length of the filament. The total emission required from the filament is determined by the use which is to be made of the valve in practice, so that if a long filament is employed, the emission can be obtained with a smaller diameter filament, so reducing the current consumption and increasing the efficiency.

Mechanical Considerations

There is a mechanical limit, however, to the reduction in the filament diameter, partly concerned with the manufacturing processes and partly a matter of satisfactory performance when the valve is made. If one could obtain, however, the advantages of a long filament, while still retaining the robustness of a comparatively thick filament, then a great advance in the science of filament design would be made.

If the current consumption is to be kept down, however, it is obvious that the old principle of heating the filament to incandescence cannot be adopted, and instead of the usual tungsten filament, some special material has to be employed. Modern research has resulted in the production of filaments which will give an emission equally as good as that of the old bright emitters at a very much lower temperature. As the temperature of the filament is increased, so the current consumption increases extremely rapidly, and, consequently, the lower the temperature at which the valve can be run, the less will be the current consumption necessary in order to maintain the filament in a state of active emission.

A modern valve of this type will give the full emission necessary at such a low temperature that the filament will not even glow. The filament is indeed operating at a "black heat," and no visible indication is obtained as to whether the filament is emitting or not. The actual emission from a given filament of stated length and diameter depends upon a constant known as the *Emission factor*, or the *Electron evaporation constant* of the particular material utilised for the filament.

The Emission Factor

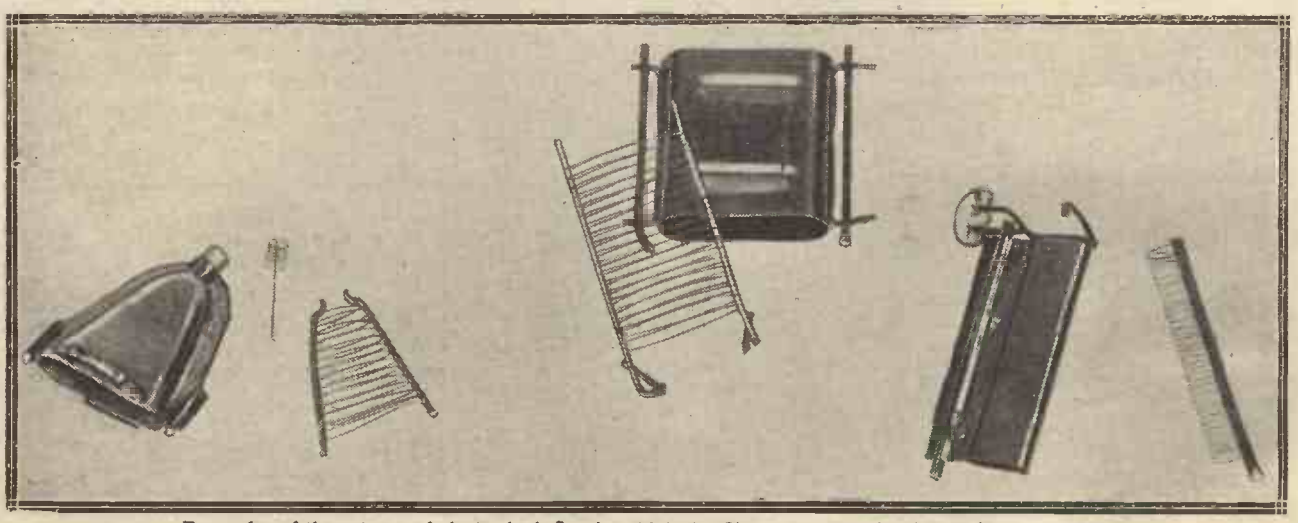
For a given design of valve we require a definite value for this emission factor, and the filament has to be designed to operate at such a temperature that this particular value is obtained. Fig. 2 gives values of the emission factor at different temperatures for a modern glowless filament, a thorium coated filament, and a tungsten filament.

It will be clear from these curves that any particular value of the emission factor can be obtained at a very much lower temperature with the first type of filament, the normal operating temperature being below red heat. With such a material we can use a comparatively long, yet nevertheless robust filament, thus obtaining full benefit of the extra length, while still requiring a very small current, of the order of 100 milliamps only, in order to operate it.

Avoiding Microphonic Troubles

There is also another very important advantage, namely, that since the filament is operating at a black heat and is not continually raised to a white heat and allowed to cool again, the structure of the filament itself is not subject to periodic internal strains.

One of the most satisfactory methods of mounting is that adopted in Fig. 3, which is known as duo-triangular suspension. With this system the valve filament is definitely held at 5 points. By this means it can be maintained perfectly rigid as far as mechanical considerations are concerned, without the necessity for any tensioning of the filament, and this practically obviates all microphonic troubles. Where the filament is mounted horizontally, the five suspension points can be made of thick wire, so that this system goes a long way towards the ideal in this direction.



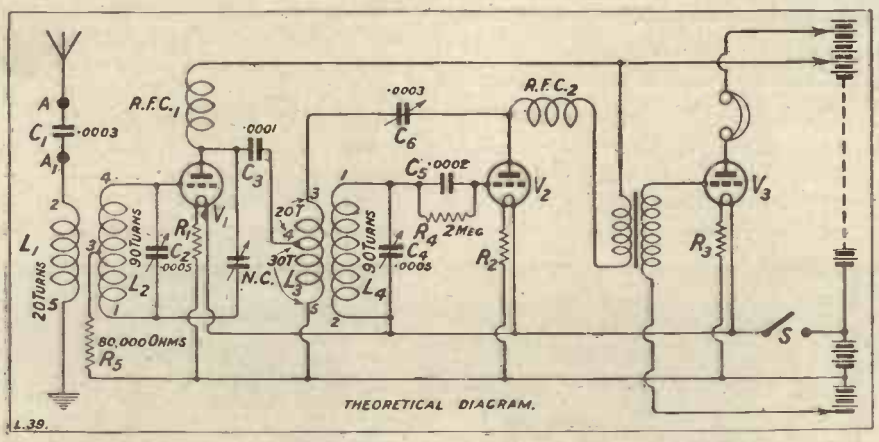
Examples of three types of electrode design in which the filament suspension has to be very secure.

The "Overseas" Three

An easy-to-make receiver which will give you a choice of programmes.

By STANLEY G. RATTEE, M.I.R.E.

THE man who wishes to build a receiver capable of giving a choice of programmes without involving too great an expenditure, should consider well the advantages afforded by the receiver to be described. In the south-east district of London at a distance of approximately ten miles from 2 LO the choice of at least three stations on the loud speaker is always available, with the option of many other stations at good telephone strength.



The estimate of three stations is, of course, a conservative one, but it will nevertheless indicate to readers that the set does not confine one to the local station, in spite of the fact that the capital outlay in components is not extensive.

Easily Controlled

To one who is used to operating a single valve set, for instance, where as a rule only one tuning control is employed, the prospects of handling three dials, as the photographs indicate would be necessary, may be a little awesome. In actual practice, however, the correct operation of these three dials is not by any means as difficult as some readers may suppose. The dial on the extreme right of the panel is merely a reaction control, in other words, there are really only two tuning adjustments, these being made by rotating the small knobs on the centre and left-hand dials. Further, since the receiver is fitted with "slow motion" dials and the readings of the two tuning condensers will always be approximately the same, the set is relatively easy to operate, in spite of its high degree of selectivity.

For local work the receiver will be found to give plenty of volume without distortion, so long as a good loud speaker is used, together with the right valves and suitable voltage values. In these circumstances it will be found totally unnecessary to use the reaction condenser, and after setting this to a zero reading and adjusting the tuning condensers to their correct readings, the set may be switched on and off, by means of the switch provided, in the ordinary manner of a family receiver.

The circuit used in the present circumstances is one of the modern types incorporating a neutralised

COMPONENTS REQUIRED.

- Ebonite panel 16 in. x 8 in. x ¼ in.
- Cabinet and baseboard 16 in. x 7 in. x ⅜ in.
- Pair panel brackets.
- 10 terminals and ebonite strip, 5 in. x 2 in. x $\frac{3}{16}$ in.
- 3 S.L.F. condensers, 2 of ·0005 and 1 of ·0003 (J.B.).
- 3 slow motion dials.
- Push-pull switch.
- 3 valve holders.
- 2 radio-frequency chokes.
- 2 six-pin coil bases.
- 2 coils as specified.
- 3 "amperites," type 1A.
- Low-frequency transformer.
- Anode resistance, 80,000 ohms, with base.
- Neutralising condenser.
- 1 fixed condenser, ·0003.
- 1 fixed condenser, ·0001.
- 1 fixed condenser, ·0002.
- 1 grid leak, 2 megohms.
- Short length of rubber-covered flexible wire.
- Wander plugs, connecting wire, screws etc.

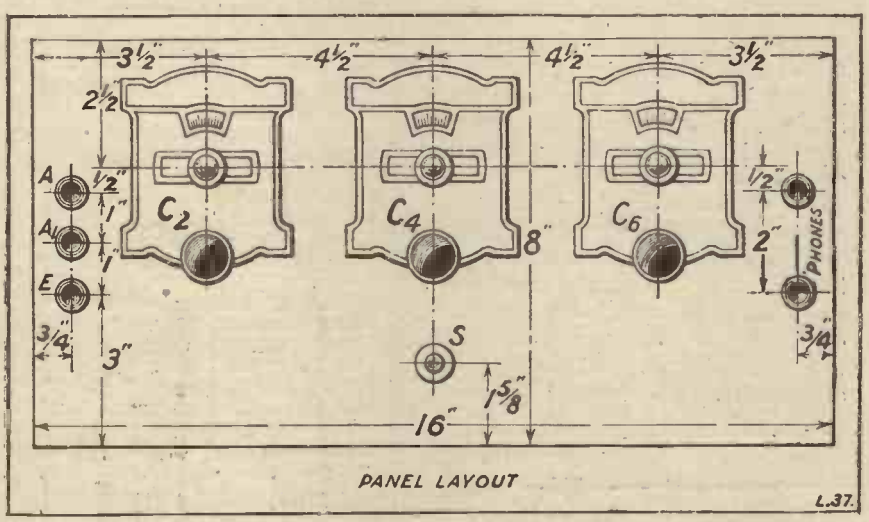
A distinctive appearance is given to the receiver by the dials used.

THE "OVERSEAS" THREE—*continued*

stage of H.F. amplification, followed by a detector and conventional note magnifier. The aerial circuit is inductively coupled to the first grid circuit, while the first valve is coupled to the second by means of a parallel-feed transformer arrangement.

The coils employed are wound upon commercially made formers and may, if desired, be purchased complete.

The coils L_1 and L_2, consisting of 20 and 90 turns respectively of taken to pin No. 1 and the bottom to No. 2. The primary winding L_3 is wound in the same direction as L_1, within the slotted portion of the former between the two halves of L_4. After 30 turns have been wound, connect the commencement of the winding to pin No. 5 and the 30th turn to pin No. 4, continue the winding in the same direction until a further 20 turns have been wound when, by connecting the end to pin No. 3 the coil unit is completed.



PANEL LAYOUT L.37.

No. 34 D.S.C., are wound upon the same former, a separating space of ¼ in. being allowed between the bottom end of L_2 and the top end of L_1. The top end of L_1 is connected to pin No. 2, while the bottom end of the same coil is connected to pin No. 5. The coil L_2 is wound in the same direction as L_1 and the top of this coil is connected to pin No. 4; at the centre point of L_2, that is, at the 45th turn, a tapping is taken to pin No. 3, while the bottom of the coil is taken to pin. No. 1.

The H.F. Transformer

The coils L_3 and L_4, which constitute the windings of the H.F. transformer, are wound upon a similar former to that used for the coils L_1 and L_2, with the exception that in the centre of the former (L_3, L_4) grooves are cut into the ribs to allow the primary winding to be placed between two halves of the secondary winding L_4.

The secondary winding is wound in such a way that 45 turns are placed each side of the grooves, making in all a total of 90 turns for L_4; the top being

If the reader will examine the photographs showing the back of panel wiring, the instructions just given will be made perfectly clear by a close inspection of the second coil, the slotted portion containing the primary winding being clearly indicated.

Though six-pin bases are used in the present receiver no provision is made for the inclusion of screens, for since the set is both stable and selective without them no useful purpose would have been served by the extra cost involved.

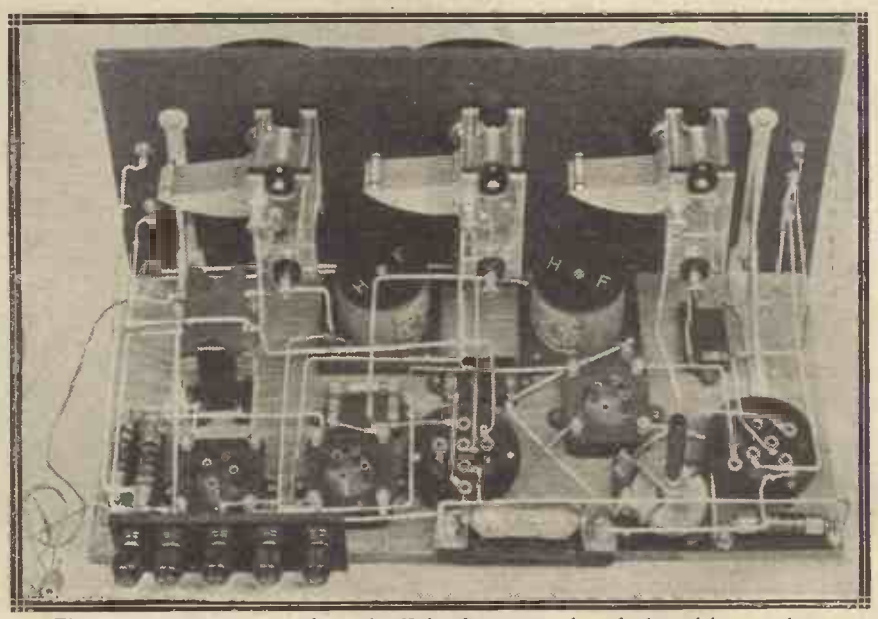
Components Advised

The list of components given separately is made up of those components actually incorporated in the original receiver, and suitable makes may of course be chosen from the advertisement pages of this journal, but the values where given should be copied.

The resistance shown in the circuit diagram as R_5 and of 80,000 ohms is not, however, particularly critical as to value and may be anything between 60,000 and 100,000 ohms; in practice it is an ordinary clip-in type of anode resistance, and if desired, various values may be tried.

The "amperites" given in the list of components are suitable for 6-volt valves, and when purchasing these components the value of the accumulator voltage and the filament voltage and current of the valves it is intended to use should be stated.

After the panel has been drilled in accordance with the lay-out illustrated the components should be mounted upon this latter and the



The components are neatly and efficiently arranged and the wiring made a straightforward task.

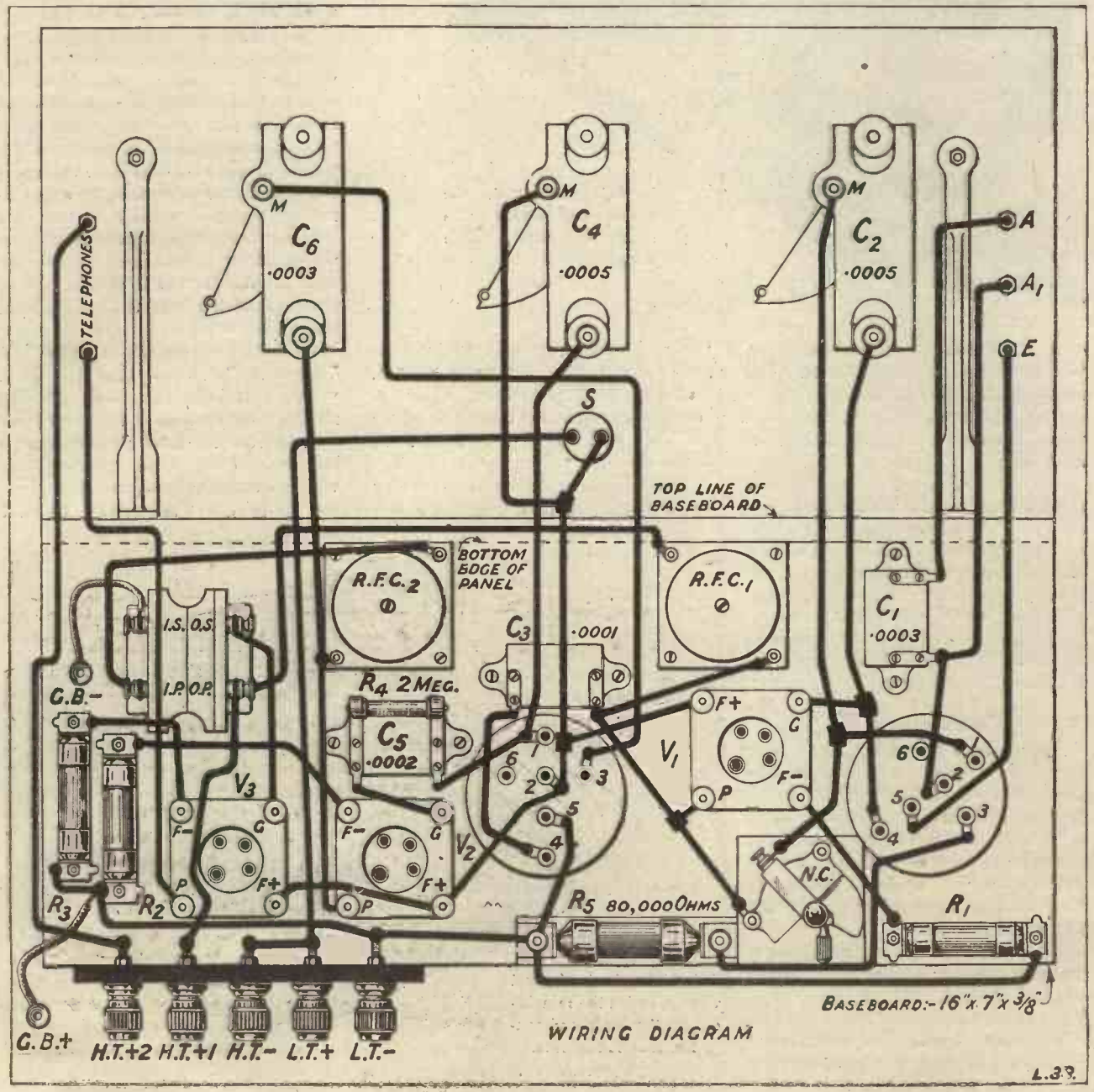
THE "OVERSEAS" THREE—*continued*

baseboard respectively, and before making any attempt to secure the panel to the baseboard the panel brackets should be secured to the latter in appropriate positions.

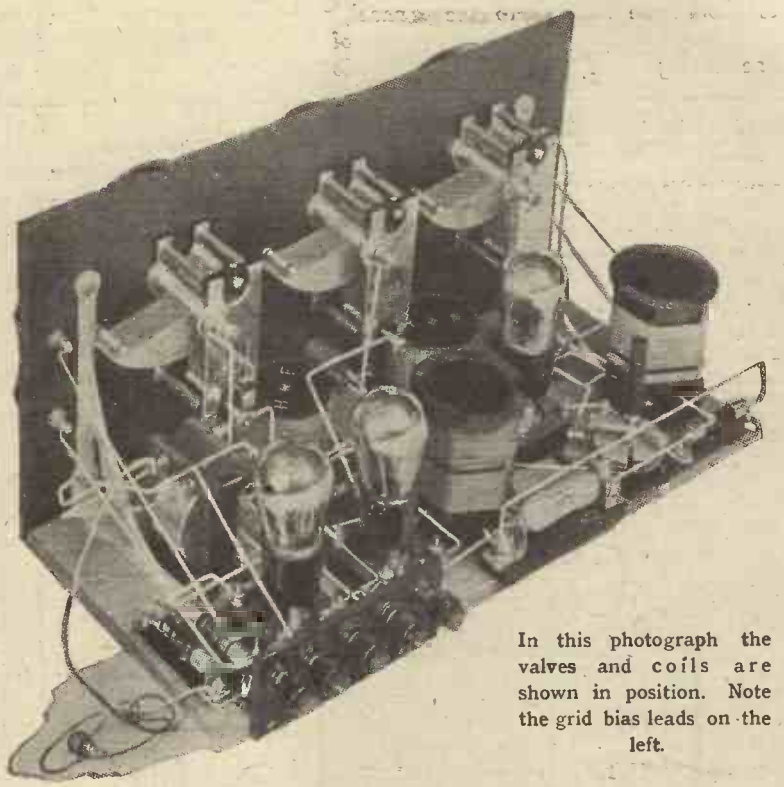
Still neglecting the fitting of the panel, make the connection from one side of R.F.C.1 to O.P. of the L.F. transformer and from one side

POINT-TO-POINT CONNECTIONS.

Join terminal A to one side of C_1.
The other side of C_1 to terminal A_1; same side of C_1 to contact 2 of L_1.
Moving vanes of C_2 to moving vanes of N.C. and contact 1 of L_2.
G of V_1 to fixed vanes of C_2 and contact 4 of L_2.
Terminal E to contact 5 of L_1.
P of V_1 to fixed vanes of N.C. and to one side of C_3; the same side of C_3 to one side of R.F.C.1.
The other side of C_3 to contact 4 of L_3.
Contact 5 of L_3 to one side of R_5; the same side of R_5 to one side of R_1 and to L.T. —terminal.
The remaining side of R_5 to contact 3 of L_2.
The remaining side of R_1 to F— of V_1.
L.T.—terminal to one side of R_2 and to one side of R_3.
Remaining side of R_2 to F—of V_2.
Remaining side of R_3 to F—of V_3.
Contact 3 of L_3 to moving vanes C_6.
Fixed vanes C_6 to one side of R.F.C.2 and to P of V_2.
Moving vanes C_4 to one side of S, to contact 2 of L_4 and F+of V_1, F+of V_2 and F+ of V_3.
Fixed vanes of C_4 to contact 1 of L_4 and to one side of C_3 R_4.
Remaining side of C_3 R_4 to G of V_2.
Remaining side of R.F.C.1 to O.P. of L.F. transformer and to H.T.+1 terminal.
Remaining side of R.F.C.2 to IP of L.F. transformer.
L.T. + terminal to H.T.—terminal and to remaining side of S.
O.S. of L.F. transformer to G of V_3.
Flexible lead fitted with black wander plug to IS of L.F. transformer.
P of V3 to one telephone terminal.
Other telephone terminal to H.T. + 2 terminal.
Flexible lead fitted with red wander plug to that side of R_3 which goes to R_2.



THE "OVERSEAS" THREE—*continued*



In this photograph the valves and coils are shown in position. Note the grid bias leads on the left.

of R.F.C.2 take another connection to I.P. of the L.F. transformer. The reason for this precaution is that when the panel is mounted to the baseboard these two connections are almost inaccessible.

Another point which will save a certain amount of difficulty is to connect two fairly long connecting wires, one to each of the contacts of the "on and off" switch, before fitting the panel in position; this switch being situated below the variable condenser in the centre of the panel is again a little difficult of access as regards connecting up.

Connecting Up

After these points have been attended to, the remainder of the wiring will be found perfectly straightforward, and though a relatively small panel and baseboard are needed for the number and type of components used, there will be found plenty of room for easy handling of both pliers and soldering iron.

Before connecting up any of the batteries, the wiring should be carefully checked against the practical wiring diagram.

When the constructor has assured himself that everything is correct, push in the switch to the "off" position and connect an accumulator suitable for use with the valve chosen, across the L.T. terminals. After inserting the coils in their respective holders, pull out the switch S, whereupon the valves should light.

The remaining batteries may now be connected to their respective terminals, with about 60 volts H.T. between H.T.— and H.T.+1. The H.T.+2 terminal is connected through the telephone or loud speaker winding to the anode of the last valve, so a voltage of anything up to 120 volts may be used, depending upon the type of valve chosen for this stage.

Adjusting Grid Bias

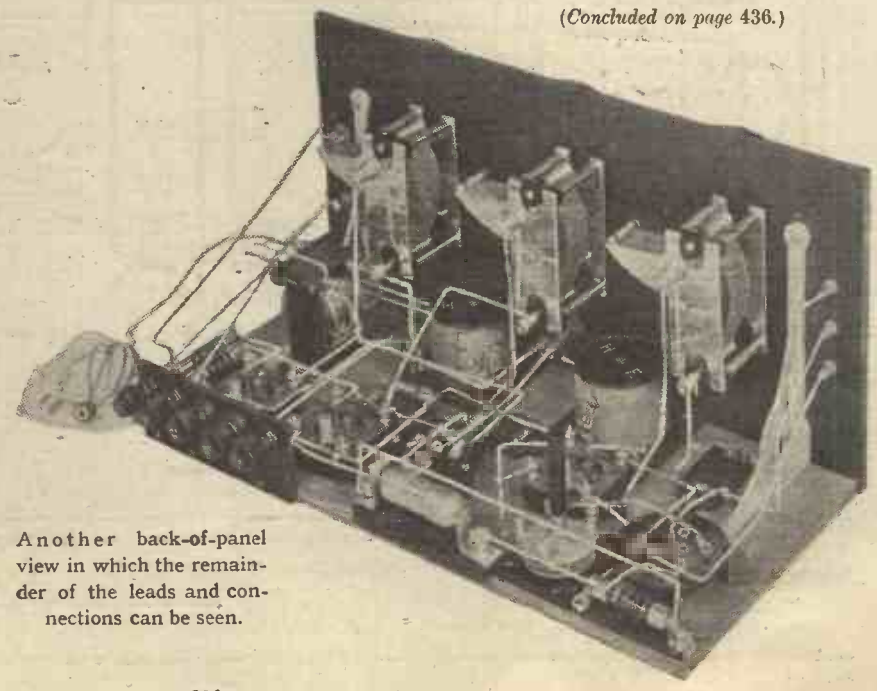
The next voltage which should be adjusted is that of the grid, and this may vary in different cases according to the valve used. A useful method upon which to work is to multiply the amplification factor of the valve by 2 and to divide this into the H.T. voltage used. For example, if we use a valve with an amplification factor of 5 and an H.T. voltage of 120, then twice the amplification factor is 10, which, divided into the H.T. voltage is 12, this figure representing approximately the grid voltage to use.

When these adjustments have been made, set all the condensers to a zero reading, and moving C_2 and C_4 one or two degrees at a time, tune in the local station to its loudest.

With this done, remove the first "amperite" R_1 so that the H.F. valve is extinguished, and turn the neutralising condenser N.C. until the signals from the local station become inaudible, even upon retuning the variable condensers C_2 and C_4.

Replace the "amperite" so that

(*Concluded on page* 436.)



Another back-of-panel view in which the remainder of the leads and connections can be seen.

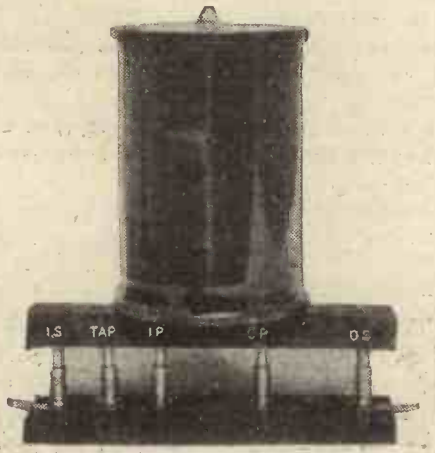
MORE ABOUT THE "COMBINE" FIVE COILS

By G. P. KENDALL, B. Sc.

In this article Mr. Kendall gives some invaluable information concerning the construction and adjustment of these coils.

THERE are certain points concerning the coils already described which were only touched upon lightly last month, and these perhaps call for a little more explanation before proceeding further. First, there is the question of the tappings on the aerial coil, and their uses.

It will be remembered that the first of the coil units comprises the usual primary and secondary windings of 30 and 80 turns respectively, the primary in this instance being the aerial



A "Combine" Five coil as manufactured by Messrs. Burne Jones.

winding, and provided in consequence with tappings at 15, 20 and 25 turns.

The Aerial Tap

The purpose of these tappings is to enable the operator to adjust the set to give the desired degree of selectivity, and also to make sure that the greatest signal strength can be obtained on any given wavelength. This is an important point, for it is quite impossible to cover the whole broadcast band efficiently with a single coil (unless an optional series condenser of suitable size is provided, of course), and it is to be understood that in passing from higher to lower waves, or vice versa, it is necessary to re-adjust the aerial tap at intervals.

In general, more turns are needed for the higher waves and fewer for the shorter ones, the actual tap to use for a given station depending upon the nature of the aerial.

The wave-length range of the coils calls for a word of explanation, also, since readers will find that it is not quite the usual 200 500 metres to which they have become accustomed. With the original hand-wound coils and in the original set with its carefully spaced wiring, the range was from a little over 240 metres to over 600 metres. Now, it is true that there are a few stations working on waves below this minimum, but if it is required to include them in the available range, it is necessary to reduce the size of the secondary windings in a way that means a loss of signal strength on the higher waves.

A Personal Matter

Whether this is worth while or not is largely a matter of personal preference. If the reader disagrees with me and thinks it *is* worth while, the procedure is simple; strip off 11 turns from each secondary winding, taking 7 from each end (to keep the tapping in the centre).

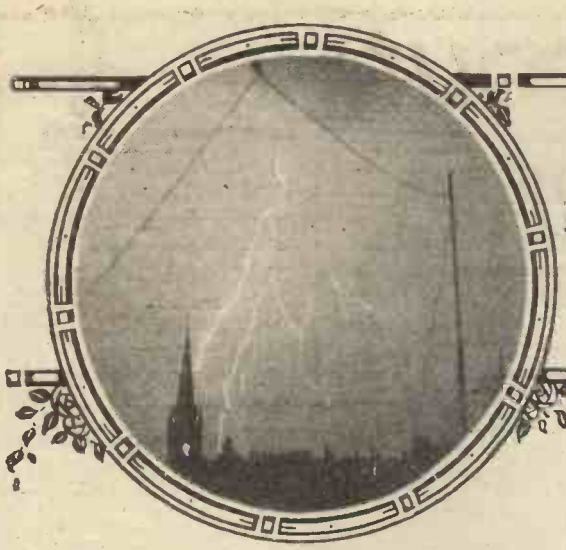
Another point which should be explained, lest the reader might be puzzled thereby, is the fact that the readings of the third condenser are different from those of the other two, although the coil is the same size. This results from the fact that the detector value grid circuit is different from the others, and does not indicate any fault.

To make the Daventry coils for this set is a task requiring a good deal more patience than the construction of the shorter wave coils, on account of the large number of turns of fine wire which must be wound. The wire is No. 40 enamelled, and considerable care is needed in its manipulation to avoid kinking or breaking. The formers used are of the same dimensions as those for the shorter waves, the length of the tube being three inches.

The turn numbers are as follow: primary, 90 turns; secondary, 280 turns with centre tap.

A final point: the coils were designed to suit a particular class of valve and to give a high degree of selectivity. For the benefit of those who wish to use a wider variety of valve types or to reduce slightly the razor-edged tuning of the set, the following design for a set of "Universal" transformers is given. The aerial winding and all the secondaries are exactly the same as before. The primaries of the second and third units, however, now have 55 turns, with tappings at 30 and 40 turns, provision being made to vary the number in use by means of a clip or other device.

When winding the fine-wire moderate tension should be kept on it to avoid kinks.



Atmospherics in the Making

From a Correspondent

THERE are very few radio enthusiasts who are not familiar with the theory of atmospherics which holds that such disturbances are due to distant thunderstorms and other electrical phenomena of an allied nature. Whilst there is much to be said in favour of this theory, it cannot be doubted that the hypothesis breaks down on occasions when, despite the presence of atmospheric disturbances, the existence of thunder or electrical storms within an extremely wide and distant range of the receiving aerial cannot be proved.

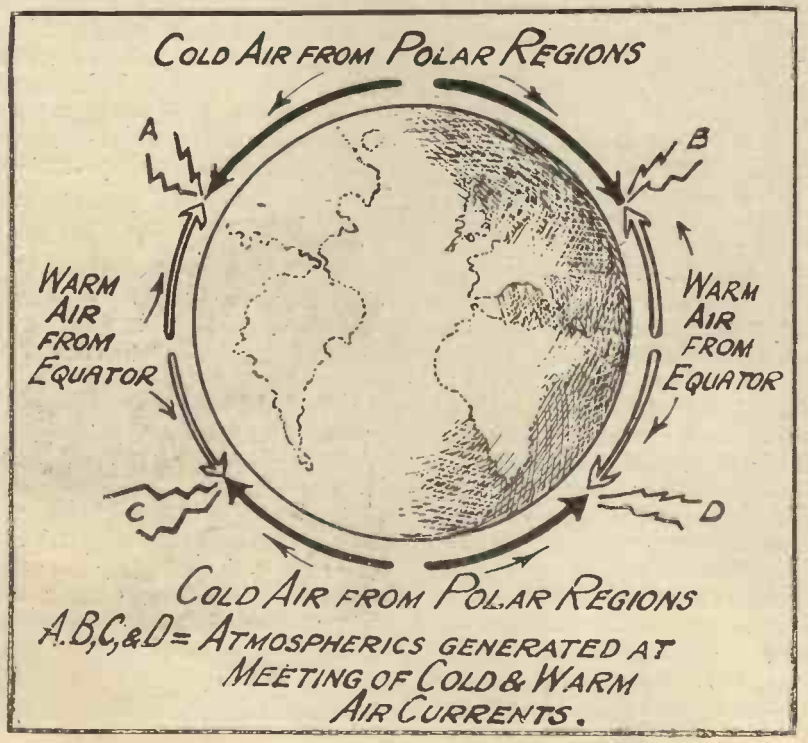
Recently, however, two French scientists have come forward with a new theory which seeks to explain the occurrence of atmospherics, especially in winter time, when electrical disturbances in the atmosphere are at a minimum.

A New Principle

These investigators, after a close and extended scrutiny of meteorological records, have been able to show that the presence of atmospherics coincides very closely with actual weather disturbances, such as heat waves during the summer.

Air disturbances have been shown to have a lot to do with the presence of atmospherics, especially those of the type which are known as "long-distance statics." In fact, the coincidence between these long-distance statics and the presence of cold air in mountainous regions during the winter time is most striking. Furthermore, it is now possible by means of directional wireless to check the direction from which atmospherics are coming.

Probably, however, the most interesting part of this new atmospherics theory is the one which brings in a new principle of static generation. Referring to the diagram, it is well known that, during the winter months, enormous volumes of cold air sweep over the earth's surface in the direction of the equator. These polar air currents, when they begin to approach the warmer regions meet with warm air currents coming from the equatorial zone of the earth. At these meeting places there are set up large-scale thermal disturbances, and, during the exchange of heat energy, a portion of the energy appears to become converted by some unknown means into electrical energy which promptly makes its presence known in the form of atmospherics.

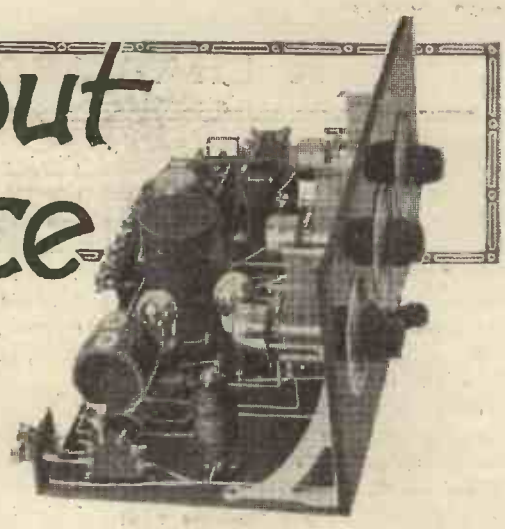


Important Practical Applications

Hence it may be very possible that the majority of atmospherics, which are not caused by thunder and electrical storms, are in reality due to the heat interaction between the intensely cold winds sweeping down over the surface of the land from the north and south poles, and the much warmer air currents which seek to travel pole-wards from both sides of the equator.

If such a theory is true, it brings with it the necessity of explaining the means whereby the heat energy of the interacting winds is partly converted into electrical energy, an explanation which, incidentally, may provide a basis for important practical applications of this at present little-understood thermo-electrical phenomenon.

A Chat About Resistance



All our elementary notions of resistance have to be modified to a very great extent in radio work, especially where H.F. is being considered. The whole situation is analysed in the following article.

From a Correspondent.

THE term resistance is viewed with both favour and disfavour in varying degrees, for no matter in what walk of life our sphere of activities may extend, the advantages and disadvantages are constantly being met. However, for the purpose of this article, attention will be confined to resistance in the electrical sense in an endeavour to see what factors govern its ultimate value.

The Electron Flow

When studying direct current electrical engineering the ideas that can be obtained concerning resistance are really very elementary and limited, and it is only when attention is turned to alternating current work, especially at the high frequencies encountered with wireless transmission and reception, that generalisation falls short, and the ideas of necessity become enlarged owing to the many factors which now make their appearance. Readers of this journal are no doubt familiar with the fact that a current of electricity is constituted by a flow or drift of extremely minute particles of negative electricity known as electrons.

The current is caused to pass round a closed circuit by the application of an electrical pressure or electro-

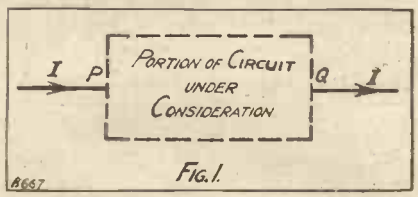
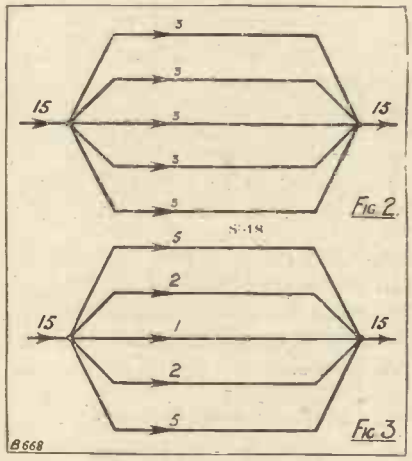


FIG. 1.

motive force (E.M.F.), such as that given by an ordinary battery, and the actual value of this current will depend partly upon the total resistance in that circuit.

The connecting wires and associated apparatus thus serve as the guiding paths for the flow of electrons, and in the simplest cases there is an elementary law governing the relation between the variable quantities. This



is known as Ohm's Law, and, expressed symbolically, gives:

$$R = \frac{E}{I}$$

where

E = Electrical pressure or E.M.F. in volts.
I = Resultant current in amperes.
R = Resistance of circuit in ohms.

Opposing Voltages

This presupposes that the voltage E is used up in overcoming the resistance of the circuit, but should there be any counter or opposing E.M.F.'s in the circuit due to motors, batteries under charge, etc., then the useful or effective pressure for accomplishing work becomes the difference between the applied pressure and the back pressure, or

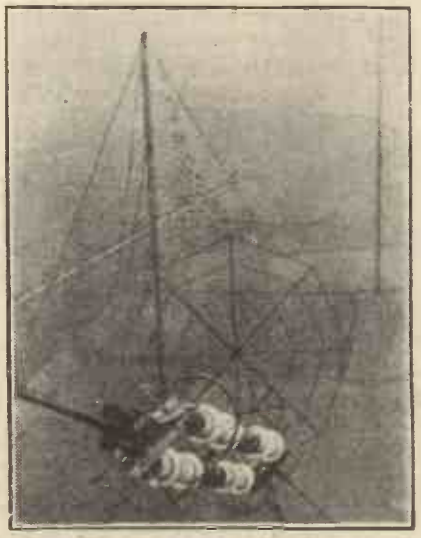
$$R = \frac{E_a - E_b}{I}$$

where

E_a = Applied E.M.F. in volts.
E_b = Back or counter E.M.F. in volts.

Now, what happens when consideration is given to the problems of alternating current? The current in this case flows first in one direction and then in the opposite, the rapidity of the changes depending upon the frequency of the circuit. The fluctuating current produces secondary voltage effects, and these are not allowed for in either of the previous formula and hence attention must be turned in some other direction for a means of appreciating the term resistance as far as H.F. work is concerned.

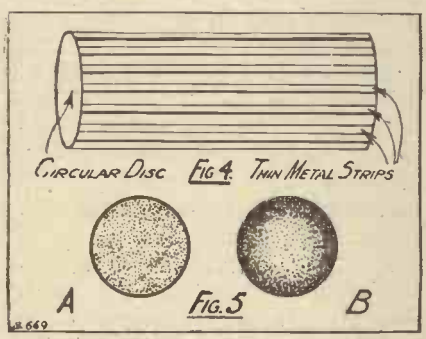
Many cases arise where the electrical energy utilised is liberated as heat, either wholly or partially, and there is another simple law which serves to define this. It is known as Joule's law, the symbolical representation being that heat generated in calories $= 0{\cdot}24I^2Rt$.
where t = time in seconds,
and R and I retain their previous meaning.



A portion of the Rugby aerial. In the case of transmitting aerials resistance plays a very important part.

A CHAT ABOUT RESISTANCE—*continued*

This certainly gives a more general expression for resistance and would seem to serve as an experimental basis for determining that all important quantity—the high-frequency resistance. The quantities t and I can be measured quite accurately, but when it comes to the amount of heat-generated the experimental determination is fraught with difficulties as a result of the errors introduced through radiation, convection, conduction, heat equivalent, etc. Approximate results are possible with

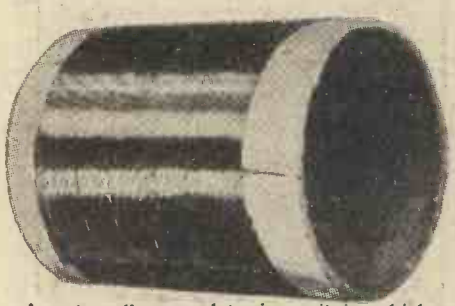


this method, but for a truer concept of what is happening one step more is desirable.

A New Conception

A little thought will at once bring to light the fact that electrical energy is dissipated in forms other than heat, indeed, the essence of successful wireless communication depends upon the dissipation of energy from the transmitting aerial in the form of electro-magnetic waves.

This leads to the idea which may seem a little strange in the initial stages, but later the reader will find that it enables hitherto difficult points



A sectionally wound tuning coil in which fine wire was employed.

to be understood with ease. The new concept of resistance has as its basis, the transference of energy to and from that portion of the circuit the resistance of which is desired. Simplification is still further possible by eliminating the time element, for the energy interchange is governed by the same time, so that it is better to deal with power, i.e. the rate at which work is done or energy utilised.

Since energy is the product of current, electro-motive force and time, i.e. I E t, then

$$\text{Power} = \frac{\text{I E t}}{\text{t}} = \text{I E}$$

This is the power in watts, since I and E are still measured in their aforementioned units of amps and volts, and since from ohm's law E = I R, then

$$W = I E = I^2 R$$

If any circuit is taken and the resistance between the portions marked off by P and Q (see Fig. 1) is required, the calculation is made from

$$R = \frac{\textit{Transferred power between P and Q}}{I^2}$$

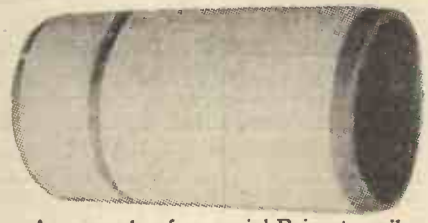
In passing it is well to notice that the power transferred may be either leaving or entering the circuit between these points.

Some of the Factors

Leaving this aspect of the problem for a moment, attention must be turned to the several factors which contribute to the resistance in degrees varying with such circumstances as frequency, material, orientation of the apparatus, magnetic and electro fields, etc. Due consideration will have to be given to:

1. The conductor resistance itself, whether this be the ordinary D.C. resistance or the more complex H.F. resistance.
2. The proximity of nearby closed circuits together with the resistance of these circuits.
3. The magnetisation of any material which is close enough to be influenced by stray fields or lines of force produced by the flow of current in the original circuit.
4. Dielectric losses in any imperfect condenser which may be present in the circuit.
5. In more or less isolated cases the effects of the corona losses.
6. Dissipation or radiation of energy in the form of electro-magnetic waves.

Space will not permit a very searching analysis to be made, but sufficient information will be given to place in a true perspective the various quantities, so that existing or future problems can be treated in a fair manner.



An example of an aerial Reinartz coil wound with thick wire.

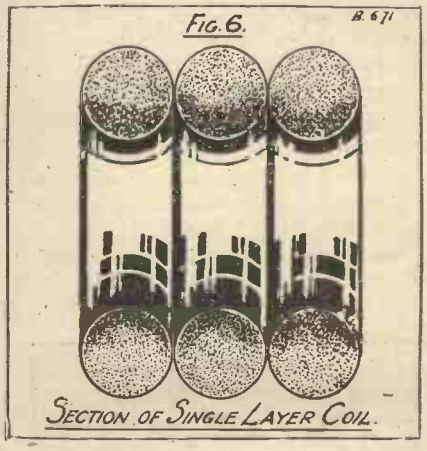
If the current passing through a conductor is evenly distributed over its cross section, the resistance can be calculated from the well-known formula

$$R = S\frac{l}{a}$$

where

S = Specific resistance of material composing the conductor.
a = Sectional area of conductor.
l = Length of conductor.

That is to say, the resistance is a simple function of the dimensions of the conductor and its material. At high frequencies, however, a different state of affairs exists for electrons flowing in the conductor do not penetrate into the inner layers or core



but confine their movements to the outer surface, since the rapidity of the changes prevent them sinking in. Thus the inner layers carry practically no current, hence the popular term "skin effect."

Indeed, this effect is so marked that the core of a conductor can be removed, so that a thin tube is formed of the same diameter without appreciably altering its H.F. resistance.

A CHAT ABOUT RESISTANCE—*continued*

Any distribution of current differing from the regular one of equal current density across a wire's section will increase the effective resistance, the increase being many hundred per cent. in certain cases.

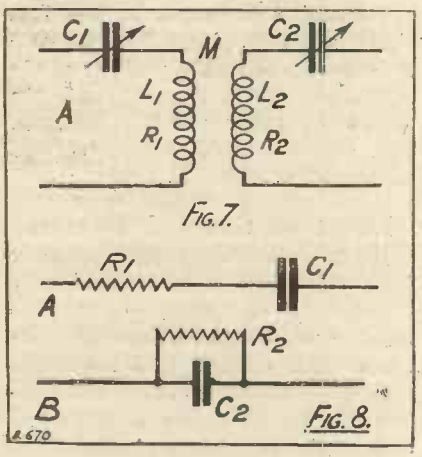


FIG. 7. FIG. 8.

As a simple illustration a conductor can be depicted as divided up into a number of separate longitudinal portions, all in parallel, and for a practical example five individual portions will be taken as indicated in Fig. 2. Assuming each resistance to be one ohm and the total current as 15 amperes, then employing the power transference idea, and taking an even distribution of current in the first case, i.e. 3 amps in each portion, then

Power lost or transferred $= I^2 R = 5 (3^2 \times 1) = 45$ watts.

$$\therefore R = \frac{45}{15^2} = 0.2 \text{ ohm.}$$

This, of course, is the same resistance as would have been obtained from the laws of parallel resistances.

H.F. Skin Effect

Assuming now that a particular circumstance alters the current distribution to that shown in Fig. 3, the total current remaining the same, then

Power lost or transferred

$$= 2(5^2 \times 1) + 2(2^2 \times 1) + 1(1^2 \times 1)$$

$$= 50 + 8 + 1 = 59 \text{ watts}$$

$$\therefore R = \frac{59}{15^2} = 0.262 \text{ ohm.}$$

Thus an increase of resistance of about 30 per cent is brought about, and other examples can be taken to illustrate the same idea, but in every case it will be found that any alteration from the simplest case, treated first, will result in a larger final resistance value.

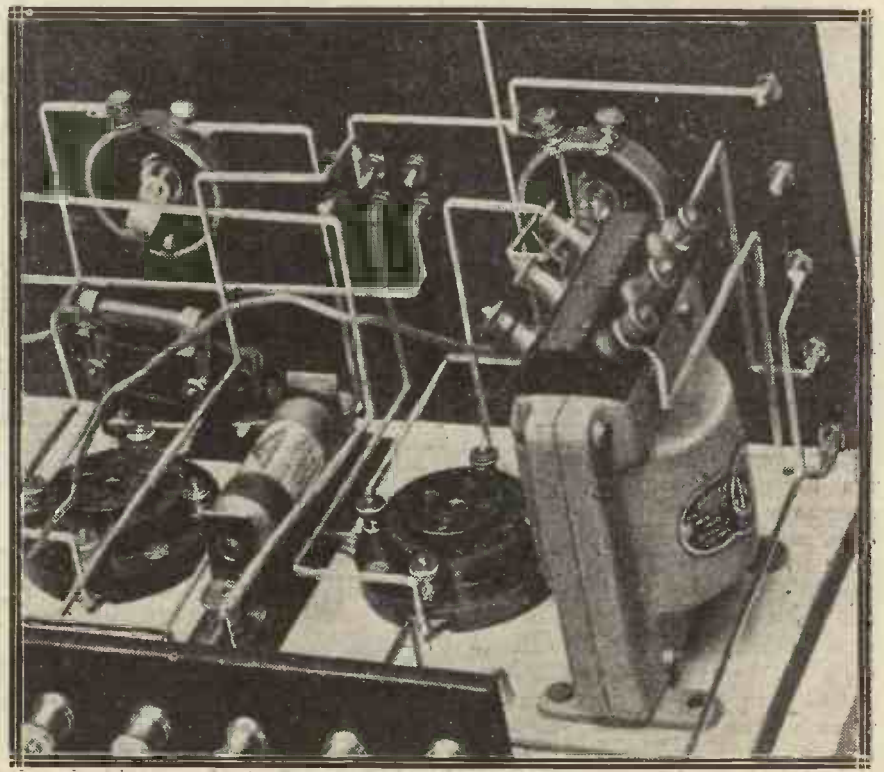
The exact mathematics dealing with skin effect in wires is somewhat complicated, but by using straight, thin wires it is possible to make the H.F. resistance almost the same as the D.C. resistance, since a wire with an exceedingly small diameter can be regarded as being all surface. This is of importance when known H.F. resistances are required for comparison purposes, and the accompanying table which has been compiled by L. W. Austin will be useful to readers making standard wire resistances of this character. It gives the largest *straight* wire which can be used without the H.F. resistance exceeding the D.C. resistance by more than 1 per cent., the wire diameters being given in millimetres.

Use of Stranded Cable

To determine wire diameters for intermediate frequencies, curves can be drawn from these figures and the required values read off.

To reduce the skin effect to a minimum, a conductor can be constructed of thin strips, connected to circular discs, as shown diagrammatically in Fig. 4, but for many practical purposes the employment of stranded cable will be found beneficial. This gives a number of fine wires all in parallel, and each of these strands must be separately insulated with, say, a thin layer of enamel. The most important point, however, is to ensure that each strand occupies a position on the outer surface of the cable at regular intervals as well as being situated at the core. This is to ensure that each wire is linked by the same amount of magnetic flux, and is brought about by braiding and twisting the cable throughout its length.

Wave-length in metres.	Frequency in Kilocycles	Copper.	Advance.	Manganin
100	3,000	0·006	0·30	0·29
200	1,500	0·045	0·46	0·40
300	1,000	0·09	0·57	0·50
400	750	0·10	0·66	0·60
600	500	0·15	0·83	0·75
800	375	0·20	0·98	0·88
1,000	300	0·21	1·10	0·99
1,200	250	0·22	1·20	1·10
1,500	200	0·26	1·30	1·21
2,000	150	0·30	1·52	1·38
3,000	100	0·33	1·82	1·62



This back-of-panel photograph of an L.F. amplifier shows an example of resistance coupling, a popular and efficient system of amplification.

A CHAT ABOUT RESISTANCE—*continued*

If this is not done the benefits conferred by stranded wire will be almost nullified. In addition, particular care must be taken at joints to ensure that each strand makes a proper electrical contact and none gets broken. For example, if stranded wire is to be joined to a solid conductor, since the moving electrons in the case of the latter are confined to the surface, the individual strands should be actually soldered all round the surface of the solid conductor with great care, and not in one solid bunch, or the current distribution will be altered considerably and the resistance increased.

Resistance in Coils

The next logical step is to consider what happens when the conductor is wound in the form of a coil instead of being used as a straight wire. Previously the distribution of electrons across the section of the conductor was changed at high frequencies from that of Fig. 5 (A) to that of Fig. 5 (B), which is equivalent to a reduction in the useful material carrying current. Now a single layer coil produces a magnetic field or lines of force inside when a current is passed through it, the density of this field being large just inside the solenoid and almost zero at the outer surface.

Now, without going into the magnetic theory, it should be apparent that, since the outer portions of the wire are linked by more lines of force than the inside portions, the electrons constituting the current flow will tend to crowd into the portion of the wire situated on the inside of the coil owing to the effects of inductive reaction. In addition, there is the neighbouring effect of one wire upon another which brings about a further redistribution of electrons, and the result is somewhat as depicted in Fig. 6.

Self-Capacity Losses

Thus results are produced which are almost impossible to predict accurately even in the simplest of coils, so the problems introduced by the multi-layer type of coil with its present diversity of windings such as duolateral, honeycomb, pile, pancake, sectionalised, etc., are difficult to calculate.

Added to this, account must be taken of the effects of self-capacity in a coil and its influence on the resistance in certain circumstances. Losses will be introduced by the presence of an internal self-capacity which will, in effect, add to the resistance of the coil, so too much care cannot be given to the reduction of this quantity by employing single-layer solenoidal coils air-spaced between turns.

Advantage of Solenoid Coil

It is fairly well established that single-layer solenoidal coils are the most efficient, but a lot of controversy exists as to the best gauge of wire to employ and the dimensions of the coil. With thick wire an unwieldy coil will result to produce a given inductance, whereas if finer gauge wire is used the dimensions of the coil will naturally be reduced.

Thus, although in the latter case the resistance of the wire is increased by its reduced cross section, this will be compensated for to a certain extent by a reduction in the length of wire required for a given inductance. A great deal of interesting experimental work can be undertaken to ascertain the optimum gauge of wire, length and diameter of coil to give the best result for any band of frequencies, the results being most usefully interpreted in terms of ohms per millihenry.

A fair amount of space has been devoted to this portion of the subject, for it is invariably the part misunderstood; and the next point to consider is the effect of neighbouring circuits. If a circuit A is coupled to a circuit B, as in Fig. 7, then it can be shown mathematically that an increase in the effective resistance of the first circuit will take place. This increase is proportional to the product of the square of the frequency and the square of the mutual inductance, and, of course, the resistance of the second circuit itself, *i.e.* $f^2M^2R_2$.

Effect of Coupled Circuits

It should be evident that the power for supplying this loss in the circuit B—and, for that matter, any other linked circuit—must be derived from the original circuit, with the result that this effects an appreciable increase in the resistance of the coil L, and must be taken into account in any calculations. Naturally, the increase of resistance will depend upon any tuning in the second circuit.

A valve which is oscillating can be made to cease by tuning to its frequency another circuit coupled to it, and this is only one of many cases which can be called to mind, the explanation being found in the extra resistance added to the first

(*Concluded on page 443.*)

The question of resistance plays an extremely important part in the design of a powerful transmitting station.

LIGHTING FILAMENTS FROM A.C. MAINS

An article of interest to all valve-users

By Capt. H. J. ROUND M.I.E.E.

RUNNING a set from A.C. mains is not superficially quite so easy as running from the D.C. mains. The production of H.T. is by no means difficult, but the L.T. presents special problems of its own, and I propose to analyse here some of the difficulties and give the various methods used to overcome them.

Graded Filament Emission

In Fig. 1 is a simple rectifying valve, with a filament F_1 and F_2 and a plate P. The plate battery V is connected to one end of the filament, and a milliamperemeter inserted to indicate the plate current flowing.

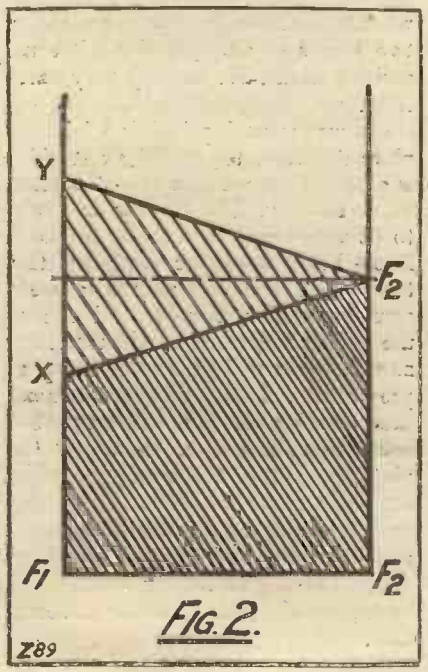


FIG. 2.

Suppose first of all the filament is lit by D.C. and F_1 is the positive leg. It is quite obvious that between the filament end F_2 and P there is full battery voltage; between F_1 and P there is less voltage by the amount of L.T. battery volts.

This means that at the end F_2 more electrons are being pulled off than at F_1. In fact, the flow of electrons will be graded from F_1 to F_2. If we reverse our L.T. battery the grading will be reversed, and the total emission from the whole filament altered.

The First Rule for A.C.

Fig. 2 shows graphically how the total current will vary in these two cases. The total current being represented by the two areas shaded in different ways. Obviously, if we light the filament with alternating current we shall be varying from the position F_2–X to F_2–Y and back again every cycle of the alternating current. The difference in the two shaded areas represents milliamperes which will vibrate the milliammeter or actuate any indicating instrument such as a loud speaker in the plate circuit.

Now we can note two things. Firstly, that the distance X Y in Fig. 2 represents twice the filament volts, so that the smaller our filament

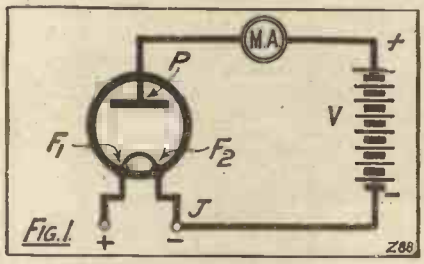
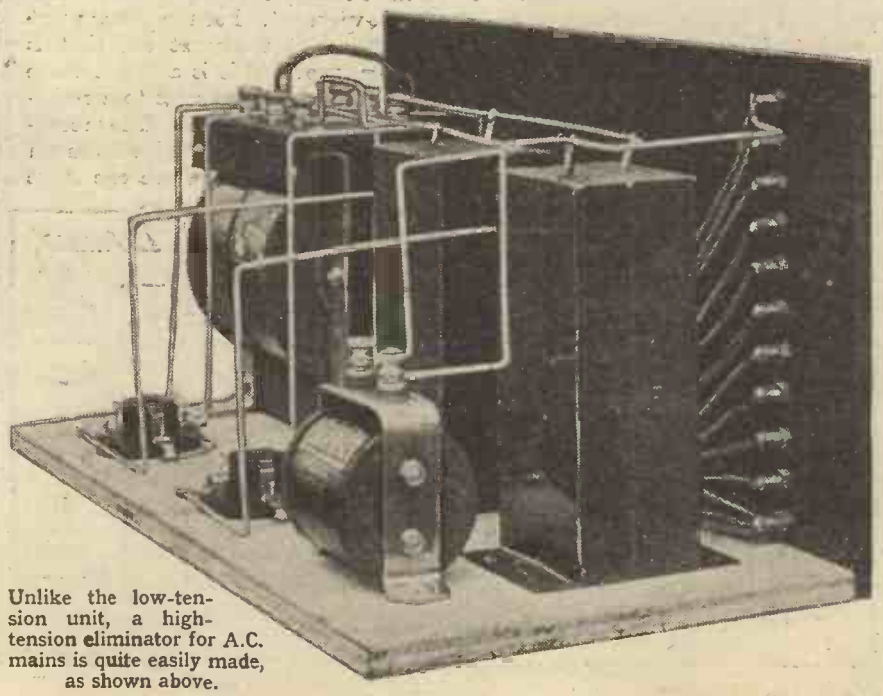


FIG. 1.

volts the less of this change we shall get due to the filament alternating current. This establishes the first rule with alternating current . . . "Use low-voltage filaments" . . . and these low-voltage filaments will in all probability be thicker than the



Unlike the low-tension unit, a high-tension eliminator for A.C. mains is quite easily made, as shown above.

LIGHTING FILAMENTS FROM A.C. MAINS—*continued*

higher voltage ones, so that any change of temperature in the filament seriously altering emission is minimised; for remember that at points in the alternating current cycle there is no current flowing into the filament, and consequently there is no heat being applied.

Type of Valve to Use

Then, again, the higher the H.T. voltage is the less percentage change does this filament drop make. The meaning of this last sentence is a little involved, because so far I have only talked about a simple rectifying valve. In a triode the volts that we have to consider are the actual ones acting between the grid and the filament.

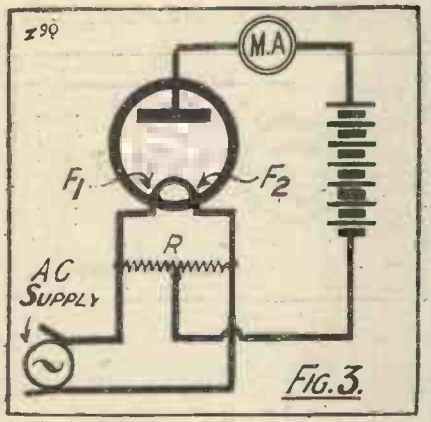


FIG. 3.

These volts, which are made up of the sum of the grid volts and the plate volts which leak through the grid mesh, decide the plate current, so that if we say instead of H.T. "volts" in the simple rectifier case must be large—the plate current must be large—we establish a second rule, which, with triodes, it is easier to see the meaning of.

This in practice means working with a low magnification valve unless one can afford to put very high volts on the high magnification valve. It is a little complicated to reason out whether one will gain with this lower percentage change of current due to alternating current. In certain cases one will definitely gain, so that either one can stick to the rule here given always or think the particular case out separately.

There is fortunately a very easy way to reduce greatly this change of plate milliamperes when using A.C., although we shall have great difficulty in bringing it to zero. Suppose we put a resistance R across the filament as in Fig. 3 and connect the bottom of the H.T. battery to the middle of the resistance. Our current diagram now becomes Fig. 4, which, if we examine carefully, will be seen to have the same area for any given alternating current voltage.

Detector Difficulties

This looks as though we are quite out of trouble, but actually we are not, for, unfortunately, a valve conductivity is not quite constant with voltage applied, so that a little ripple will still be left, much smaller than before, however; but if we use this arrangement in conjunction with the two previous rules, we shall have a fair chance of working.

Let us examine a set, and in Fig. 5 I have merely represented the valves in a 5-valve set. For the power valve we need not worry at all, that is certain, provided it is a 2-volt valve and we centrally connect to a resistance across the filament. The preceding valve also will not give us much trouble, although we have one stage of magnification now to beat, and a transformer stage with a low-impedance valve looks more promising than a high-impedance valve and a resistance coupled amplifier. But

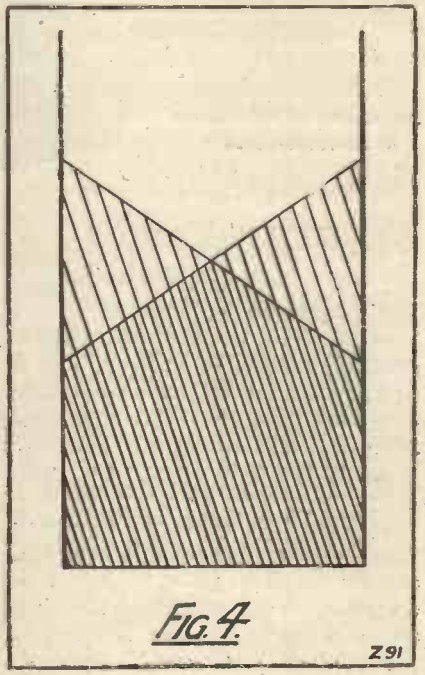
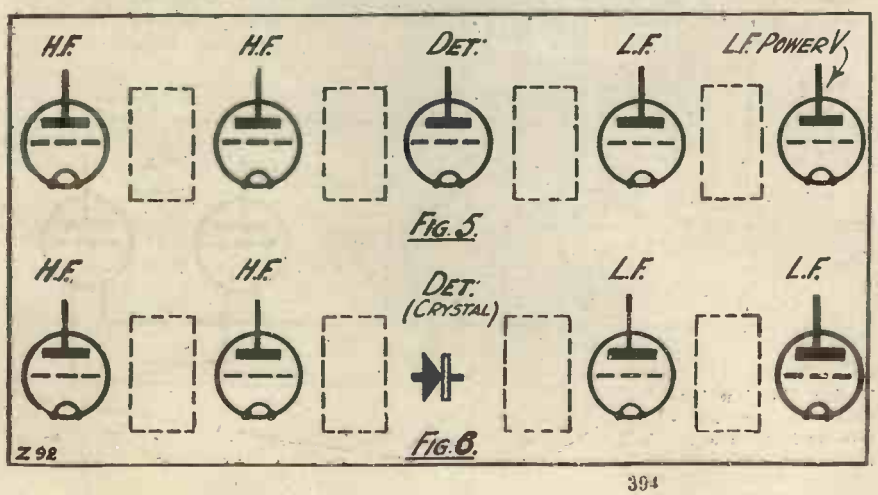


FIG. 4.
Z91

when we come to the rectifier we have two stages of amplification after us, and we shall have to step very carefully.

On my overall principle of heavy plate currents, the grid leak rectifier is a better proposition than the plate bend rectifier, but neither is likely to be very silent, and many methods have been used for dodging this trouble. The easiest way is to use a crystal rectifier, Fig. 6, and one of the carborundum or semi-permanent zincite types will be a good working proposition. I personally recommend this solution of the difficulty, but some ingenious sets, in which the plate current of the whole set when supplied by a rectifier is incidentally used to light the rectifier filament—usually a ·06 ampere type have been made. One can hardly recommend them, however, for amateur construction.



Grid-Leak Rectification

I should recommend to try grid-leak rectification with a low-voltage filament valve of low impedance, such as the D.E.P. 215, first, and if with the aid of central connection the

ADVICE FOR INVENTORS

Conducted by Dr. J. H. T. ROBERTS, F. Inst. P.

Readers sending in inventions under this Department should state clearly whether they are willing for their inventions to be published and discussed in this journal. Otherwise, so far as is possible, communications will be treated in confidence, but at the same time it must be clearly understood that no responsibility whatsoever is, or can be, accepted either by this Journal or by the Author in connection with any patents or suggestions submitted, or in connection with any matters arising out of the same, and all persons making use of this Department or communicating with it in any way are to be deemed thereby to have accepted the foregoing conditions.—EDITOR.

FOLLOWING my request last month that those experimenters who submitted inventions to me should state whether or not they were willing for their inventions to be published and discussed in these columns, a rather curious position has arisen, although perhaps it is one which it was not unnatural to expect. Most, or practically all, of the many readers who have written to me have asked me not, at the present stage, to disclose their inventions in this Journal, and this means that the number of *really interesting* inventions left over for discussion in print is depleted. So far as I can judge from most of the letters received, it seems likely that the same position will continue to prevail, so I think it will therefore be better to publish only a few selected inventions in this section. There are many which could be published and discussed, but, unfortunately, in those cases where permission is given by the inventors for their ideas to be disclosed the inventions are not generally of interest to a sufficiently large number of readers to warrant taking up very much space in discussing them.

I think, therefore, that it will probably be better in the future if this Inventors' Section deals more with general matters by way of hints to inventors as to the development of their ideas, getting them on the market, and so on, and I propose to arrange for replies to definite queries to be dealt with privately by post.

Of course if, from time to time, inventions of real interest come along, and the inventor is willing for them to be published, they will be detailed in these columns for the benefit of other readers.

At the same time I should be very glad if any of you who have any general questions to ask, which you think would be of sufficient interest to other experimenters to justify public discussion, will kindly forward the same addressed to this Section.

LIGHTING FILAMENTS FROM A.C. MAINS

—concluded from page 394.

noise is too much, throw out the valve and fit in a crystal, preferably of the semi-permanent type.

With L.F. the troubles we get are obviously that the unbalanced alternating current magnified gets into the loud speaker. But, of course, this cannot happen in the H.F. stages, because the H.F. circuits form a complete block to L.F. currents. The way the alternating current noises cause trouble in this stage is as follows.

H.F. Stage Variations

Owing to imperfect balancing of the alternating current, slight variations of plate current are taking place in the H.F. valves all the time. Now, the magnification of a H.F. stage is slightly dependent upon the plate current, because a valve characteristic is not quite straight, so that if we tune to a carrier wave that carrier wave will be amplified to a varying degree, which is the equivalent of modulating it. This modulation will at once be shown up by the rectifier and the L.F. magnification. Fortunately, the trouble is of a second order, as the mathematician says, but again, low-impedance valves—so that one is working well on the straight part of the characteristic—will be necessary, and the other rules of low-voltage filaments and central taps still apply.

The central tap resistance can, of course, be made common to all the valves in parallel, and placed across the lighting transformer, and with four ·12-amp. 2-volt valves, a ten-ohm resistance, split at the centre, will be suitable. As most of our troubles are due to L.F. magnification

A crystal detector of the "permanent" type is recommended by Captain Round.

of the alternating current noises, the tendency in our A.C. filament receivers should be to keep the H.F. magnification up and the L.F. down.

In Fig. 7 I show a skeleton diagram of the commou central tap arrangement. Some prefer to split the transformer-winding at the centre, and tap on to the centre, but the resistance scheme is very nice for balancing.

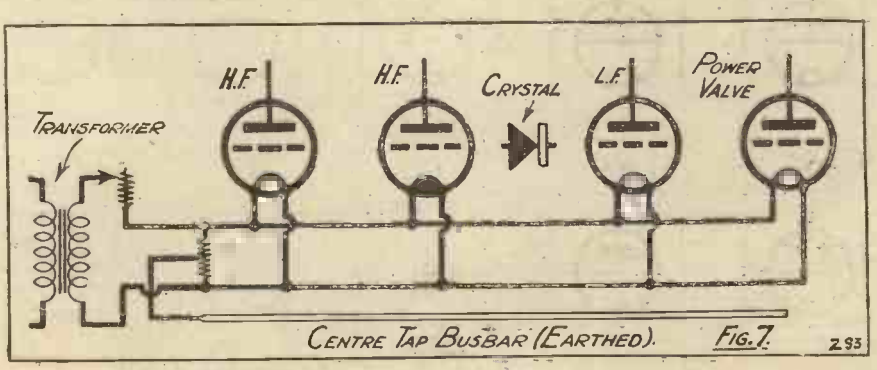
AN OAK CABINET

From a Correspondent.

Few amateurs decide to use oak for their cabinets because the wood is very hard, and more important still, the gallic acid in oak very quickly rusts away iron or steel screws.

The hard nature of the wood can be overcome by using a good saw, and brass wood screws prove quite suitable if precautions are taken.

A hole should be punched or drilled to the full depth of every screw, and it is advisable to countersink deeply near the surface to clear the unscrewed part of the screw under the head, so that there is no breaking off before screwing home.



WHAT READERS THINK

NOTE.—All communications, MSS., photos, etc., should be addressed to the Editor, "Modern Wireless," The Fleetway House, Farringdon Street, E.C.4. In cases where a reply is required, a stamped and addressed envelope must be enclosed.

"Blind Spots"

SIR,—With reference to your article on "Blind Spots," in the February issue of MODERN WIRELESS, perhaps a few remarks on "blind spots" on the West Coast of Africa might be of interest.

These I have not noticed with broadcasting, but for commercial working to ships, etc. Sierra Leone station is screened by the high mountains to the southward, and reception of this station is almost impossible when more than 100 miles south of it. Also when north of it amongst the Bejuga Islands, off Bissao, it is difficult and some times impossible to work with Sierra Leone, the reason being a little obscure, as there are no mountains intervening, and the islands are small and very low lying.

Seawards of these islands the "blind spot" continues; at 360 miles north of Sierra Leone reception is normal, while at 300 to 320 miles north it is very difficult.

Gibraltar North Front station is also screened to ships steaming fairly close to the Atlantic coast of Morocco, just north of the Canary Islands, while Cadiz, only 60 miles west of Gibraltar, is quite normal.

Apparently the cause of this is either the presence of the mountains over at Tangier, or else the situation of the wireless station with regard to the Rock itself.

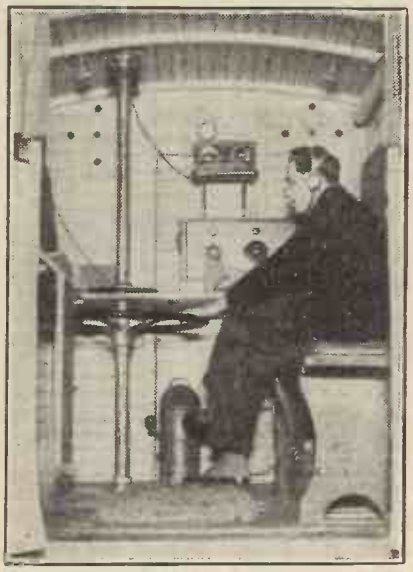
With regard to broadcasting reception on the West Coast, that is very often completely spoiled by the atmospherics, which are particularly strong in that part of the world. With a "Harmony Four," however, I have been able to receive many Continental stations, as well as four or five of the British Isles stations. Bournemouth is the best of these, while Dublin runs it very closely. I have received the former from Lagos, Nigeria, but have had no opportunity of experimenting further south than that. North of Dakar both are received at loud-speaker strength.

Of the Continental stations, Madrid and Barcelona have been found to be the best, but possibly further experimenting in the Mediterranean will change this opinion.

Wishing your paper every success.

Yours truly,

"ANTI-ATMOSPHERIC."



The Radio Detective, trailing oscillators in a specially equipped patrol van.

Tranode Two-Valve Set

SIR,—I put together the above set from the January number of MODERN WIRELESS, and find the circuit a very excellent one. I have added a transformer-cum-choke two-valve amplifier, and get very fine loud-speaker results.

For some considerable time I have ceased to try out the circuits given as so many new parts were required.

Can you not give us more of such circuits like the above?

The original three-valve Transatlantic set was a very fine one, and I think suggestions for modernising this set would be appreciated. I have recently added slow-motion dials and reaction, and find a great improvement.

Yours faithfully,

Bristol. W. B. CUMBERLAND.

"Peculiar Short-Wave Fault."

SIR,—Your correspondent, J. Westlake (writing in the January issue of MODERN WIRELESS), will probably find he is using either too large a choke, an unsuitable valve, or else a transformer not suited to the circuit. In many cases the connection of a variable grid leak across the secondary of the L.F. transformer will cure the trouble, and I have often found this succeed where other attempts have failed.—Yours truly,

Radlett. M. G. THOMAS.

Short-Wave Reception

SIR,—On Sunday, February 6th, during the hours 11.30–12.30, 3–3.30, and 6.30–7.30, using the detector portion only of Mr. Simmonds' short-wave receiver, as given in the February number of MODERN WIRELESS, but using a D.E.R. valve as detector, I received over 50 amateurs, transmitting telephony, in addition to others in France, Belgium, Germany and Holland.

In the evening at 6.30 a church service, on a W.L. under 10 m., was heard. The source was not identified.

The British transmissions were heard mainly from the London area, but also from Lichfield, Eastbourne, Leeds, Leicester, Clacton and Northern Ireland, the latter apparently replying to the transmitter at Clacton who asked for reports from that area.—Yours truly,

W. W. WOODMAN.

Willesden, N.W.10.

Design of Small Power Transformers

By Dr. J. H. ROBERTS, F. Inst. P.

IN these days of eliminators, chargers and so on, the small power-transformer is coming to play a more and more important part in the outfit of the experimenter. Theoretically, a small transformer is the simplest thing in the world to make: it consists of a primary winding and a second winding placed upon an iron core and, according to the simple formula, the voltage generated in the secondary bears the same relation to the voltage in the primary as the number of turns in the secondary

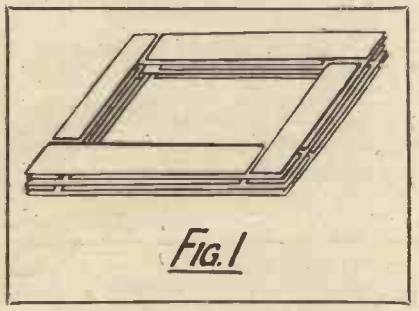


FIG. 1

bears to the number of turns in the primary.

Acting on this simple supposition, many experimenters have set to work lightheartedly to construct small transformers and have then been disappointed to find that the finished article did not come up to their expectations as regards either performance or efficiency.

The truth is that there are many important details, both of design and

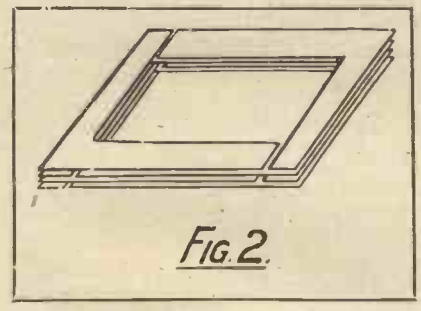


FIG. 2.

construction, which I regret to say are not properly dealt with in textbooks and articles on this subject. I have often noticed descriptions in articles and textbooks which were quite misleading and which indicated a lack of any real appreciation of the scientific principles involved, as well as an

A half-wave transformer employing a core similar to Fig. 2.

absence of practical experience of the subject.

In the first place, let me say that the simple rule that the voltage-radio of the secondary and primary is the same as the turns—ratio represents an ideal condition which is never attained in practice. It pre-supposes that the whole of the magnetic flux created by the current in the primary winding passes through the secondary winding. In a well-designed transformer this may be very approximately true, but in a badly designed transformer it may be very far indeed from being true, and the voltage generated in the secondary winding may be no more than 50 per cent of that which would be expected according to the simple rule referred to.

Avoid Air Spaces

In building a transformer it is convenient to wind the coils upon cylindrical spools, but a more efficient arrangement is to use a square or rectangular section spool into which the soft-iron laminations may afterwards be fitted. A glance at Fig. 1 will show the way in which the soft-iron core may be built up from strips, assembled into the spool after the windings have been completed. It will be evident that if the core is built up in this way (and this is practically the universal way of building up a core of this kind) there will be a considerable air space surrounding the core if the spool is of the cylindrical variety. This air space causes loss of efficiency, but the matter is not a very serious one in small transformers and, so far as the experimenter, at any rate, is concerned, it is rather a refinement to go in for a rectangular spool instead of a cylindrical one.

It is not necessary to say very much about the windings themselves, a spool long enough and deep enough to accommodate the required number of turns of the proper size wire will obviously be necessary, and, in addition, it is very desirable to insulate successive layers of wire, either with a sheet of empire tape or with waxed paper. Even a sheet of ordinary dry typewriting paper is much better than

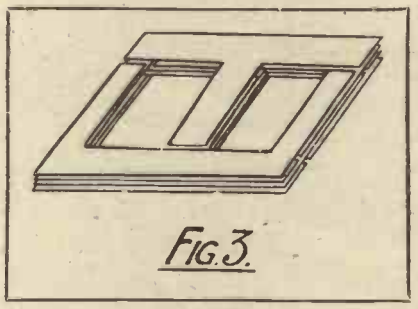


FIG. 3.

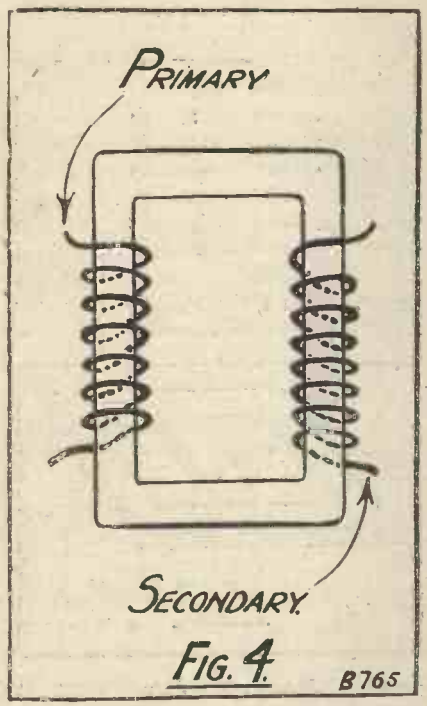
nothing. However, I do not want, at the present stage, to dwell too long on the question of the actual windings, as that is an important subject in itself.

Let us deal for the moment with the general features of design and the arrangement of the core. Fig. 2 shows soft-iron "Stalloy" strips stamped out into the shape of the letter L.

This full-wave transformer, specially designed for H.T. eliminators, has a core similar to Fig. 3

DESIGN OF SMALL POWER TRANSFORMERS—*continued*

These are inserted into the coils in the alternate manner indicated in Fig. 2, so that the two gaps in one pair of stampings are adjacent to a continuous portion of the next stamping; in other words, so that the gaps do not all come at the same place. In this



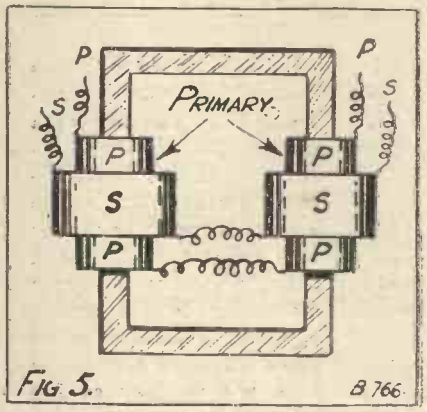
way the extra magnetic reluctance which would be occasioned by the gaps is largely avoided.

In Fig. 3 the magnetic circuit is made up of two types of "Stalloy" stamping, one in the shape of the letter T and the other in the shape of the letter U. These again are alternately reversed for the reasons indicated in the preceding paragraph.

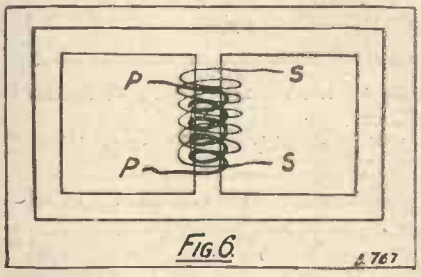
A Bad Design

Fig. 4 shows diagramatically a transformer consisting of a closed iron circuit, with primary wound upon one limb and the secondary upon another. I have actually seen this arrangement described in articles and recommended to constructors, but constructors who acted upon such advice would find themselves very wide of the mark when they put their transformer to the test. The fact is that the design indicated in Fig. 4 is about as bad as anything could very well be. It will be seen that the induction of current in the secondary winding, depends entirely upon the magnetic flux conducted round the iron circuit from the pimary, and if you could map out the magnetic field, and could thereby have an occular demonstration of the magnetic leakage taking place, you would not be surprised that the voltage and the power generated in the secondary, with this design, would be only a fraction of the maximum theoretical value. In a few words, Fig. 4 shows how *not* to design a transformer.

Fig. 5 is an infinitely better arrangement. Here a half of the primary is



wound upon one limb, then the usual crossover, and the remaining half on the other limb. The secondary is then wound on the top of the primary, half on the first limb and the remaining half on the second limb. We thus have, in effect, two transformers in series both electrically and magnetically. In the case of each transformer

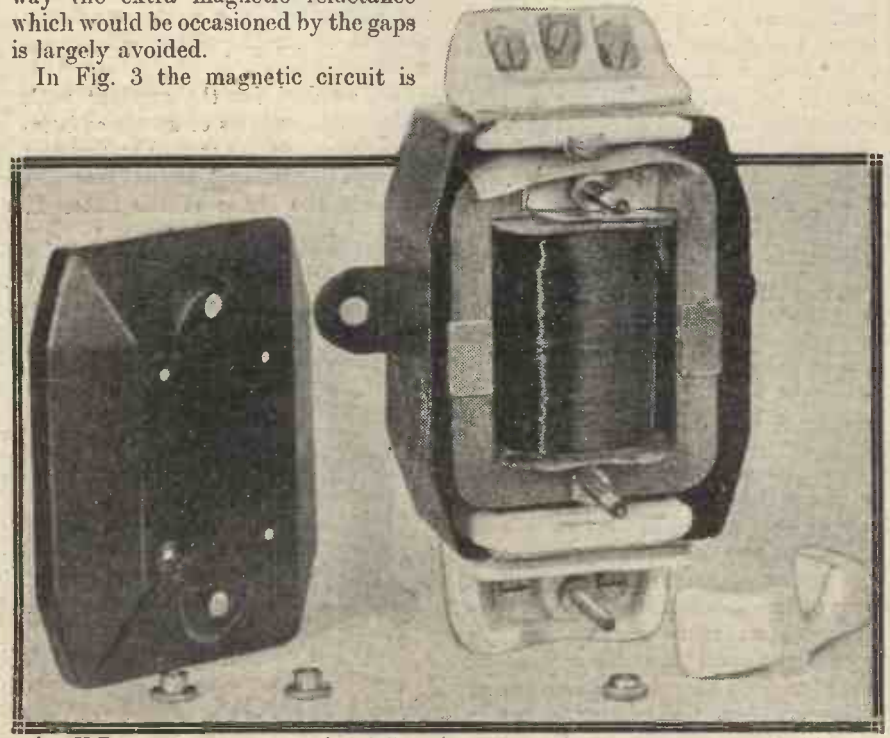


the primary and the secondary are arranged as closely together as possible, so that the condition that the secondary coil shall embrace as much as possible of the flux created by the primary is fulfilled. Fig. 5 represents a perfectly sound arrangement as regards general considerations

Greater Path for Flux

In Fig. 6 a still better arrangement is shown, for here the primary and secondary are wound round the same region of the magnetic core, and the magnetic flux has a considerably greater return path inasmuch as it can return by two paths in parallel.

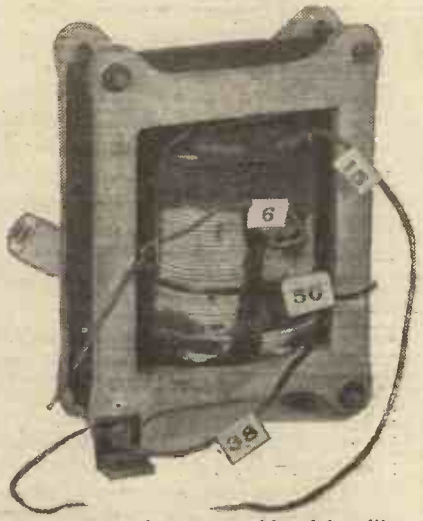
Fig. 7 shows an arrangement such as that in Fig. 4, but, owing to the relative shape and dimensions of the windings and the iron core, the conditions are even *worse* than in Fig. 4 Not only is the primary entirely on



An H.T. power component for full-wave work which is wound on the Fig. 6 system.

DESIGN OF SMALL POWER TRANSFORMERS—*continued*

one limb and the secondary on another, but the primary is wound as a short "fat" bobbin instead of a longer, slimmer one, with the result that the magnetic leakage from the primary coil itself is very much increased. Furthermore, the primary



A power-transformer capable of handling 200-300 watts. Note the method of taking the secondary tapping.

and secondary coils are mounted upon the *short* limbs of the iron core and the flux has to find its way from the primary to the secondary by conduction through the *longer* limbs of the core.

The result of this design would be that the percentage of the flux from the primary actually entering the secondary would be very small, and for practical purposes the efficiency of the transformer would be so low that the instrument would be useless.

Fig. 8 shows a very much better arrangement. Here the windings are made fairly long and slim and they

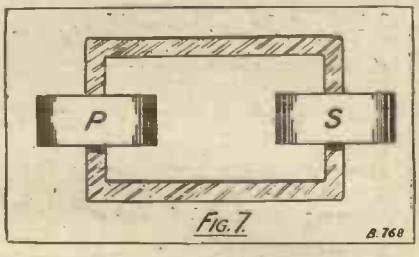


FIG. 7.

are placed as close together as possible, so that the magnetic path from the one to the other is as short as it can be. If, in addition, the primary and secondary be wound half on each limb, as in Fig. 5, then the design shown in Fig. 8 will be a very efficient one, and the voltage generated in the secondary will be approximately that given by the simple formula, whilst the power developed in the secondary will not be much inferior to that supplied to the primary.

Below is given the actual formula by which to design a small power-transformer for any given voltage ratio and power output, showing sizes of wire and cross-sectional area of iron core.

I would like to remark at this point that there is often a tendency for constructors to "skimp" the iron in the core. This is unwise for several reasons. In the first place, the smaller the core the greater the amount of copper wire which has to be used, so that the saving in expense in one direction is off-set by the increase in another. In the second place, if the iron core and the winding be skimped, the transformer will tend to get hot when working, and will also consume more than an inappreciable amount of current when "running idle" (that is, when the primary is connected to the mains but there is no load on the secondary). In the third place, with an inefficient magnetic circuit the transformer will be unable to show a proper overall efficiency.

The Essential Formula

Now a few figures to enable the experimenter to calculate the essential points in the design of a small power transformer.

The number of turns of wire required on the primary depends upon the voltage of the mains to which the primary is to be connected, the frequency of the supply (commonly called the "periodicity"), the magnetic flux density of the material which is used for the core (which is usually measured in "lines" per square inch), and upon cross-sectional area of core.

If we denote these quantities respectively by N the number of turns on the primary, E the EMF of the mains to which the primary is to be connected, F the periodicity, B the flux density of the core material, and A the cross-sectional area of the core in square inches, then the formula is as follows:

$$N = \frac{10^8 + E}{4.4 + F + B + A}$$

The magnetic properties of the core will, of course, depend upon the nature of the material; ordinary sheet iron may be taken as capable of carrying a flux density of about 30,000 lines per square inch, transformer steel about 40,000 lines, whilst some of the better qualities of transformer iron may even carry up to 50,000. It will be a fairly

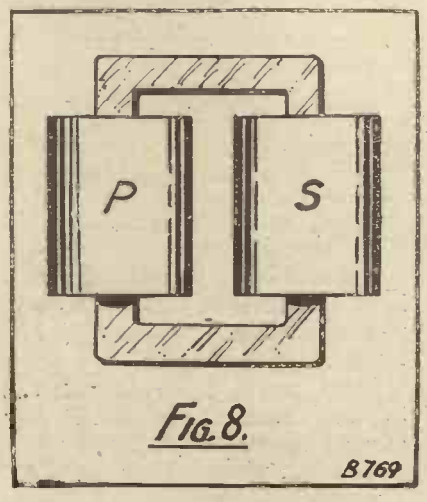
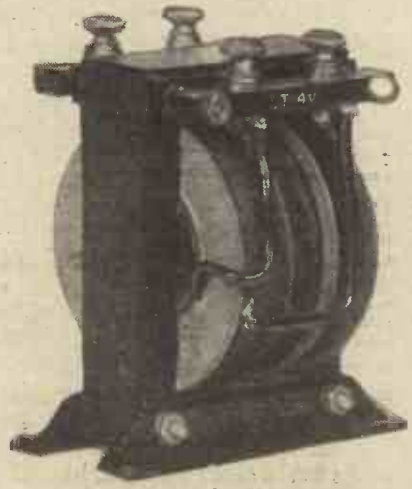


FIG. 8.

safe rule with good transformer iron to assume round about 30,000 to 40,000 lines per square inch, and for safety it would be better to assume the lower figure, that is 30,000 lines.

A simple example will indicate the way in which this formula is used.

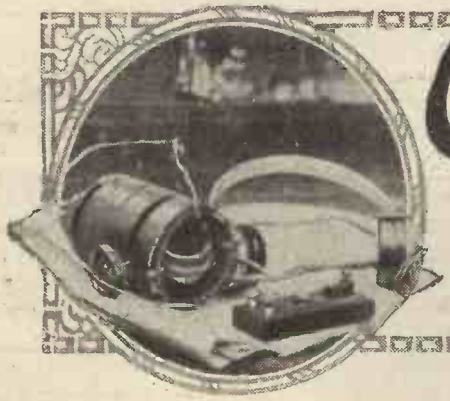
Suppose the voltage of the mains is 220 volts, the periodicity 50, the



A small power transformer in which the bobbins are wound separately and placed on the core as units.

material of the core capable of carrying 30,000 lines flux density per square inch, and the cross-sectional area of the core 2 square inches; then substituting in the above formula

(*Continued on page 445.*)



Questions Answered

Obtaining Selectivity

P. M. R. (Sutton).—"I possess a 3-valve set, Det. and 2 L.F., which, while giving me an excellent volume on 2 L O, does not allow me to receive any other station.

"Tuning on the variable condenser is extremely 'flat,' the local transmission being receivable nearly 'all round the dial.'

"Can you tell me how I can improve selectivity? I do not wish to scrap the set nor yet tamper with the internal wiring, because, as I am a novice, I am more likely to damage something than improve things. I don't mind altering my aerial, H.T., valves, L.T., or coils, but leave this to you. If you could give me some alternative suggestion I should be extremely obliged."

Your trouble is not uncommon, unfortunately, and can be due to a variety of causes.

In the first case, probably your aerial system is to blame, and we therefore advise you to satisfy yourself as to its efficiency from the following details:

Its total length should not exceed 100 ft., and this includes the length of the leading-in wire up to the aerial terminal on the set. It can be of the single-wire type, and should be composed of stranded wire. 7/22 bare or enamelled wire (seven strands of No. 22 gauge is commonly used), but the wire can be composed of a greater number of strands or have a larger surface area. The earth wire should also have a large surface area, and for best results it can be of a similar gauge to the aerial wire, and be rubber covered. Its length should not exceed 20 ft. if avoidable, and it can terminate at an "earth tube" driven into some damp soil or else be clamped by a special clip to a *main* water-pipe.

The leading-in wire (down lead) of the aerial system must, under no circumstances, be arranged so that it runs parallel with any walls, but should be at an acute angle to them, say 45 to 60 degrees.

As examples of this fact, we would suggest you examine the photos of leading-in wires of powerful transmitting stations and note the angle at which they are brought in. In most cases it is at 90 degrees to the walls. These same remarks apply to the leading-in wire after it leaves the leading-in tube. Keep it well away from ceilings, and, if necessary, suspend it on porcelain insulators fitted at the end of small wooden rods projecting from the walls or ceilings.

The horizontal portion of the aerial should not be less than 25 ft. from the ground, but if it can be raised to 40 ft. or more above the ground level, so much the better. In practice it works out that the nearer the aerial is to the ground the "flatter" the tuning.

If the above points do not affect the trouble, we are afraid that the fault lies in the set itself.

THE TECHNICAL QUERIES DEPARTMENT.

Are you in trouble with your set?

Have you any knotty little radio Problems requiring solution?

The MODERN WIRELESS Technical Queries Department has been thoroughly reorganised and is now in a position to give an unrivalled service. The aim of the department is to furnish really helpful advice in connection with any radio problem, theoretical or practical.

Full details, including the revised and, in cases, considerably reduced scale of charges can be obtained direct from the Technical Queries Department, MODERN WIRELESS, Fleetway House, Farringdon Street, London, E.C.4.

A postcard will do: on receipt of this all the necessary literature will be sent to you free and post free, immediately. This application will place you under no obligation whatever.

Every reader of MODERN WIRELESS should have these details by him. An application form is included which will enable you to ask your questions, so that we can deal with them expeditiously and with the minimum of delay. Having this form you will know exactly what information we require to have before us in order completely to solve your problems.

Last Stage Valve

V. S. (S.E.21) asks if it is really worth while using a super power valve for last stage work. This "all depends," of course. If you want really big volume and the ordinary power valve will not carry the grid voltages applied to it you must use a super power. Similarly a super power valve will usually bring out the low notes better, *but* do not forget that it requires about 14–18 milliamps for plate current, and you will need a really good H.T. battery—preferably of the accumulator type with large capacity if you can manage it. For moderate loud speaker work an ordinary power valve should be sufficient.

* * *

The Elfin Four

B. E. M. (Radlett).—"I have built the "Elfin Four" described in last month's MODERN WIRELESS, and while I get excellent results on distant stations I find the local is not as purely reproduced as I would have expected where resistance-coupling is employed. I use 6-volt Cossor valves throughout with the R.C. type for detector and first L.F. An ordinary L.F. valve is used for the last stage, as I cannot afford to run a super power valve because of the H.T. How can I remedy the distortion?"

Your trouble is due to overloading of the last valve and possibly of the first L.F. valve as well. With valves having a very high magnification it is easy to produce such a large voltage swing on the last valve that even a super power can hardly deal with it.

Your best plan is to substitute the first L.F. valve with a Cossor H610, which has a smaller magnification factor, and to replace the last valve with a power valve with a larger grid swing. It is rather unfair to expect the Cossor 610D to handle the grid voltages available in the last stage.

Light Sensitive Crystals

An informative article dealing in a practical form with the amazing effect of light upon different crystals.

From a Scientific Correspondent:

IF we use the term in its strictest and widest sense, the phenomenon of crystal sensitivity to the influence of light has been known for many years. Is not, for example, the light-sensitive emulsion which is coated upon a photographic plate or film, merely a medium in which microscopic light-sensitive grains of silver salts are embedded? Again, the selenium cell is no new invention. It is well over a quarter of a century old. Yet that device employs selenium in a minutely crystalline form. It is, therefore, but another application of crystal light-sensitivity.

A Simple Experiment

Within very recent times, however, the expression "light-sensitive crystal" has taken upon itself quite another meaning, for not more than a few months ago it has been shown in this country that certain varieties of naturally occurring crystalline minerals are actually able to convert light energy into electrical energy. That is to say, suppose you allow a beam of light to fall upon the surface of one of these crystals (the crystal being, at the time, connected in a closed circuit with a very sensitive galvanometer), a direct current will be found to flow through the circuit.

That is one recently discovered line of research in the subject of crystal technics. Another one, hardly less interesting, is to be seen in the fact that if two metallic sheets, separated from each other by a sheet of ebonite or other insulating material, are allowed to stand for a few days in the dark, and in a solution of one of their salts, the metallic surfaces develop light-sensitive properties. Let us deal with this latter discovery first of all, for it is one which can very readily be put to the test by the average amateur.

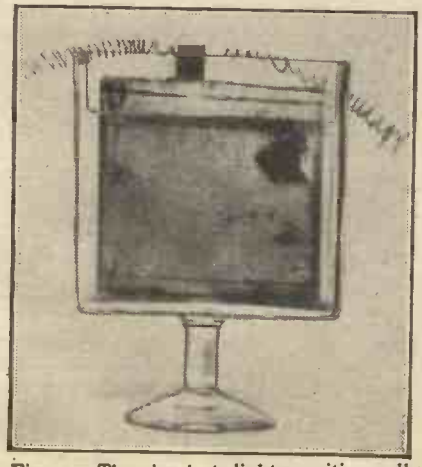


Fig. 1.—The simplest light-sensitive cell.

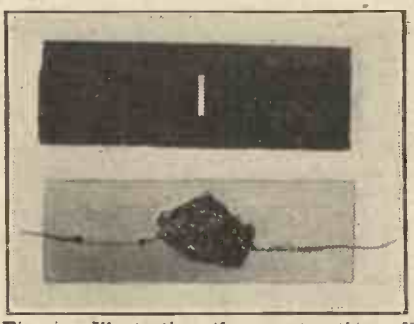


Fig. 2.—Illustrating the construction of a molybdenite cell.

Take two small sheets of any common metal—copper, zinc, iron, for instance—and bind them up tightly with string or rubber bands, taking care, of course, that a sheet of insulating material, such as ebonite, slate, mica, etc., is placed between them in order to prevent any direct short circuit between the two metal sheets. Next, place the sheets in some suitable glass container, and fill up the latter with a *weak* solution of a metallic salt of the same metal as that of which the sheets are composed. That is to say, if you use copper sheets you must immerse them in a weak solution of copper salt (copper sulphate, for instance). If you employ zinc sheets, you must use a solution of a zinc salt, such as zinc sulphate. And so on.

Having immersed the sheets in a solution of a suitable metallic salt, place the whole apparatus in a perfectly dark place, and allow it to remain there for about a week. After this time, the surface of the sheets will have become light-sensitive, and all further experiments should be conducted in a darkened room.

Minute Crystals.

Fig. 1 shows the apparatus consisting of two metallic sheets bound up with an insulative separator between them and immersed in a solution of a metallic salt.

Now, if a beam of light from an ordinary electric bulb, or, in some cases, even a humble oil lamp, is allowed to fall on the surface of one of the metal sheets of the cell, a current will be registered if the two sheets are connected up in series with a sensitive moving coil galvanometer. Moreover, the flow of current will be maintained for quite an appreciable time before fatigue sets in.

Here we are dealing with a phenomenon connected with the light-sensitivity of certain crystals. During the period at which the metallic sheets are immersed in the sensitising solution, a microscopic crystalline deposit is formed upon them, and it is to these minute crystals that the light-sensitive properties of the cell are due.

Three specimens of the well-known rectifying crystal galena.

LIGHT SENSITIVE CRYSTALS—*continued*

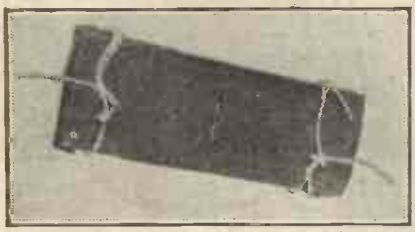
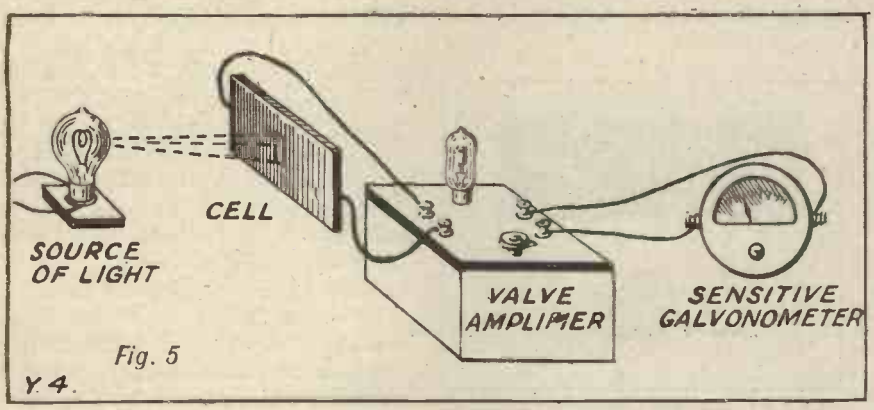


Fig. 3.—The completed molybdenite cell.

A somewhat different line of research is the following one which has indicated the fact that certain varieties of natural crystals and minerals possess light-sensitive properties. The natural mineral which has been found to possess the greatest sensitivity to light is *argentite*, a native sulphide of silver. This is a mineral which is found in small quantities in different parts of the world. Unfortunately, however, it is fairly rare, and so, also, are the majority of the other twenty to thirty varieties of minerals which have been found to possess one type or other of light-sensitivity.



One mineral crystal, however, which has been shown to possess light-sensitivity and to act as a direct converter of light energy into electricity is the mineral, *molybdenite*, a rectifying crystal well known to the wireless amateur. Fortunately, molybdenite is not scarce. Its current price is 10d. per ounce (I quote from the list of a well-known London firm of mineral and chemical dealers), and thus a supply of the commodity is well within the reach of the amateur.

The Molybdenite Cell

In appearance, molybdenite is not unlike galena, the mineral of which so many of the present-day proprietary rectifying crystals are composed. Molybdenite, however, generally takes the form of flat plates, which tend to "peel" in much the same manner as mica.

Now, in order to make a molybdenite cell, take two pieces of sheet glass, about 3 ins. by 1 in. (microscopic slides do very well for the purpose). Cover one of the slides over with black paper, leaving a small slit, about an eighth of an inch in width, in the middle of the slide. This is shown in the photograph, Fig. 2. A suitable piece of molybdenite is then placed on the other glass slide, and wire connections are taken from opposite sides of it. The black paper covered slide is now placed on the top of the lower slide, and the two are bound up together, the finished molybdenite cell having an appearance similar to that indicated in the photograph, Fig. 3.

If the leads of such a cell are connected to a microammeter or to a sensitive galvanometer, and a light is held in front of the narrow slit in the cell, a reading will be observed on the recording instrument, thus indicating that the crystal molybdenite has generated a small current under the influence of light.

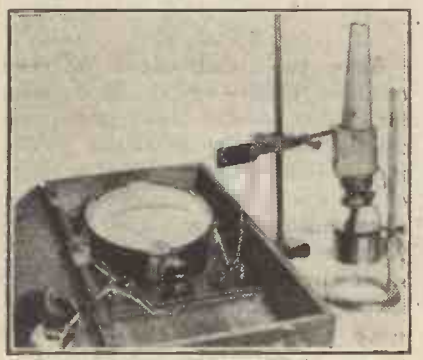
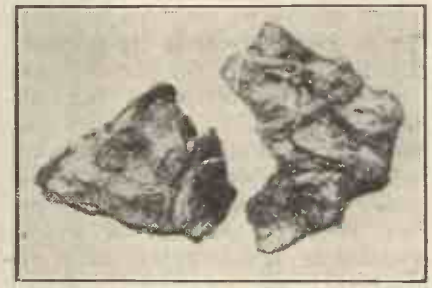


Fig. 4.—A light-sensitive cell in use.

A rough experimental arrangement for producing these effects is that shown in Fig. 4. Here a special type of oil lamp is employed as a source of illumination. Under these conditions, however, the current generated by the crystal is extremely minute, being of the order of something like 2-7 microamps. Bigger currents, however, can be generated by holding a piece of burning magnesium ribbon in front of the slit in the molybdenite cell.



Crystal molybdenite which is light-sensitive and converts light into electrical energy.

Such are the outlines of a series of fascinating experiments which may be conducted by any average amateur at a very low cost.

Sensitive Meter Essential

There is one point about them, however, which must be stressed, if only to avoid disappointment on the part of the amateur experimenter. It is that there is little use in undertaking experiments with light-sensitive cells of this type unless you have available a suitable measuring instrument. An ordinary galvanometer, a voltmeter, an ammeter, or even a milliammeter will not do. In order to register the minute currents generated by the crystal under the influence of light, you must use either a specially calibrated microammeter, which, unfortunately, is an expensive instrument, or else one of the many patterns of sensitive moving coil galvanometers which are on the market at the present day.

The reason for the above is obvious. The currents generated are so small that they would not have any effect on an ordinary instrument. Let us take concrete examples. An argentite cell will develop, under good conditions, up to about 30 microamps. A molybdenite cell has a maximum output, under the most favourable conditions, of anything up to 10-12 microamps. On the other hand, the current generated by wet cells of the

LIGHT-SENSITIVE CRYSTALS

—concluded

type described in the first portion of this article is rather better, being somewhere in the neighbourhood (at a maximum) of 70 microamps. Thus, for registering currents of these orders, a really sensitive instrument is required, and disappointment will inevitably result if experiments are conducted without such an instrument.

Of course, by using an amplifier, these small currents may be enhanced in magnitude considerably, but even under these circumstances they may not ultimately be sufficiently large enough to influence an ordinary recording instrument. However, for experimenters who would like to make attempts in this direction, a suitable amplifying circuit is shown in Fig. 5.

The mode of action of these cells is not difficult to appreciate. When

A specimen of the rare mineral Argentite, which has been found to possess light-sensitive properties.

a beam of light is allowed to fall upon one of the metal plates (in the case of the wet photo-electric cell, the other plate being in darkness), or upon a particular area of the crystal (in the case of the molybdenite or argentite cell), negative electrons leave that particular plate or crystal area. They become torn away from their atoms by the influence of the light.

The Electron Displacement

Hence the metal sheet or the local area of the crystal becomes positively charged. A small difference of potential is set up. Other electrons flow into the places occupied by the ones detached by the light's influence. These, too, are torn off. The whole action is more or less continuous (until a mysterious type of fatigue sets in), and thus a direct current of small proportion flows through an external circuit made between the plates of the wet cell, or the opposite sides of the crystal in the case of the dry photo-electric cell.

The above phenomena are interesting ones from a purely scientific point of view, because they show us still another of the many physical effects of light. And, from a practical standpoint, who can say that these definitely established facts may not prove to be the germs of some very important application ?

Practical Applications

The uses for photo-electric cells are daily becoming more and more manifest, not only in the science of television and for applications of a radio nature, but also in many other branches of technical activity. Astronomers, for instance, are now employing special types of photo-electric cells for the purpose of making minutely accurate determinations of stellar time.

Is ordinary crystal galena light-sensitive ? That seems to be a question which it might interest some amateur to investigate. According to one or two professional experimenters, galena crystals treated in the same manner as molybdenite exhibited well-developed light-sensitive properties, whilst, according to others, these statements remain unconfirmed. Personally, I have tested out about twenty different specimens of galena, but I have not obtained any positive results.

It will be interesting to hear the results obtained by readers who carry these experiments still further, for there is a great deal yet to be done.

RADIO NOTES AND NEWS OF THE MONTH

A Feature in which our Contributor brings to your notice some of the more interesting and important Radio News Items of the Month.

Conducted by P. R. BIRD

The Ide(a)s of March

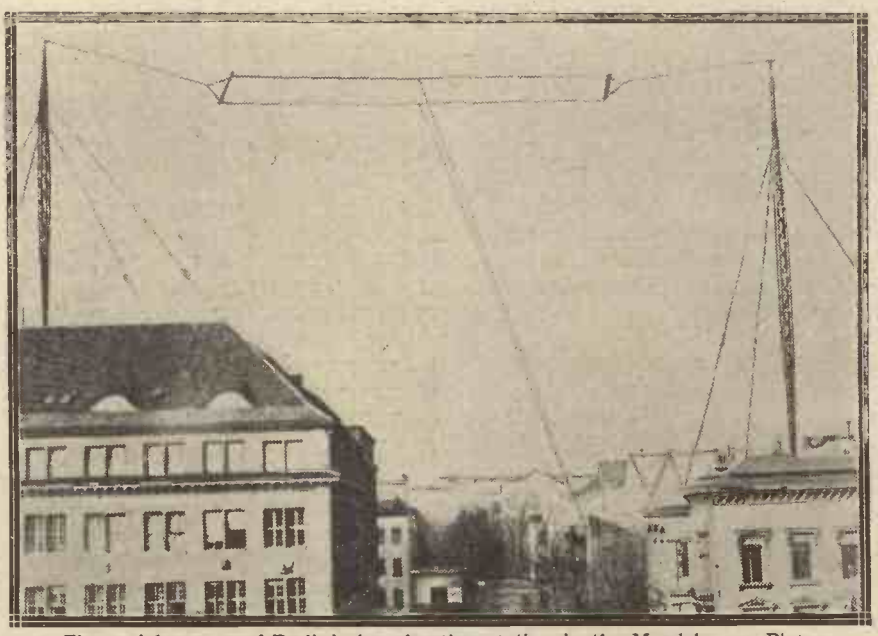
ALTHOUGH March is always supposed to be a quiet month from a radio point of view, there have been plenty of developments and new ideas during the last few weeks. A good crop of new stations was reported, and some of the old friends are spring-cleaning with a vengeance. The Berliners, for instance, are busy increasing the power of Konigswusterhausen, and there is talk of employing 100 kilowatts there, thus making it the most powerful station in Europe.

Second London Station?

At the time of writing there is no confirmation of the interesting rumour about London's stand-by transmitter at Marconi House. It was said that alternative programmes might have been sent out from there within the next few weeks, but for the fact that the Air Ministry " went up into the air " about it !

Londoners who have noticed the Air Force aerial in Kingsway will not be surprised, for the jamming when Marconi House steps on the gas just across the road must be truly awful.

(*Continued on page* 446.)



The aerial system of Berlin's broadcasting station in the Magdeburger Platz.

Another Cossor

—new series of 6-volt Valves giving remarkable volume and exquisite tone

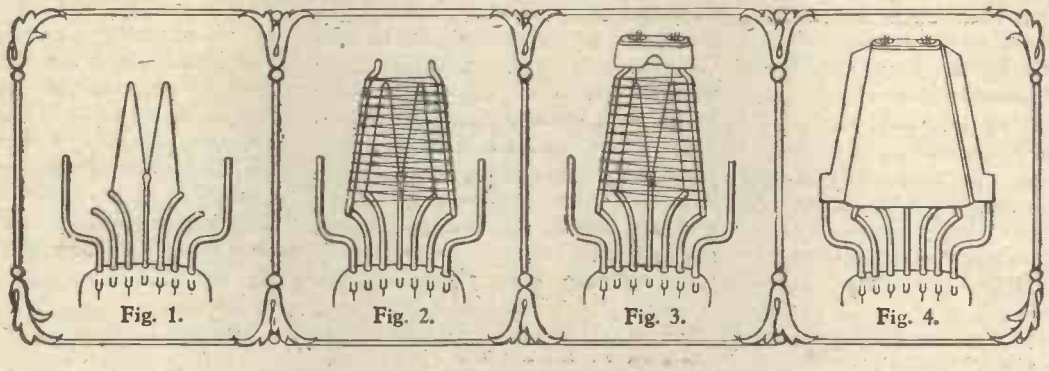
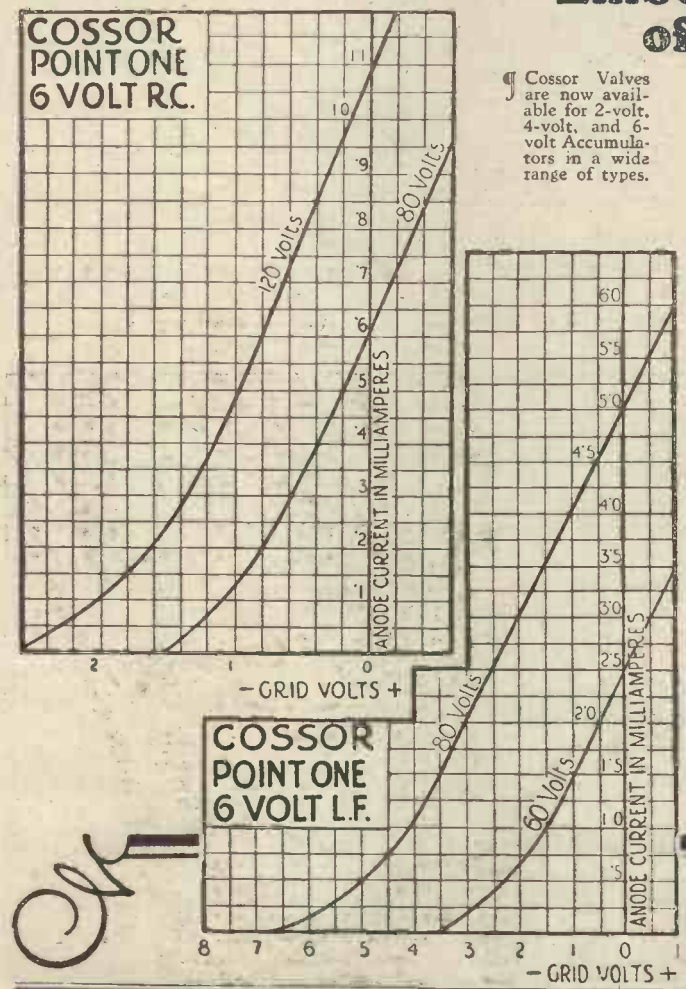


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

Embodying the principles of Co-axial Mounting

¶ Cossor Valves are now available for 2-volt, 4-volt, and 6-volt Accumulators in a wide range of types.



WHEN Cossor introduced Co-axial Mounting at the commencement of the present season it was acknowledged to be one of the greatest improvements in Radio. At one blow it abolished the main cause of lack of uniformity in valve manufacture. These same successful principles have been retained for the new Cossor Six-volt Valves. Look at the illustration above which shows how Co-Axial Mounting is successfully achieved.

In Fig. 1 see the twin filament of exceptional length. And the grid, its wire securely welded in 28 different places—which is so rigid that microphonic noises are utterly impossible. Note the seonite insulator in Fig. 3. holding immoveably in position the ends of the grid and also providing a bridge for the two shock-proof filament supports, And finally, see how the anode is locked in position in accurate and life-long alignment with the grid and the filament. All three units are secured to each other and individual movement is impossible.

Throughout its whole life the characteristics of the valve can never change through filament sag or accidental blow. How important this is, will be appreciated by every serious experimenter. All Cossor Six-volt Valves in the same class must be identical in every respect—there can be no variation.

Ask for **Cossor 6-**

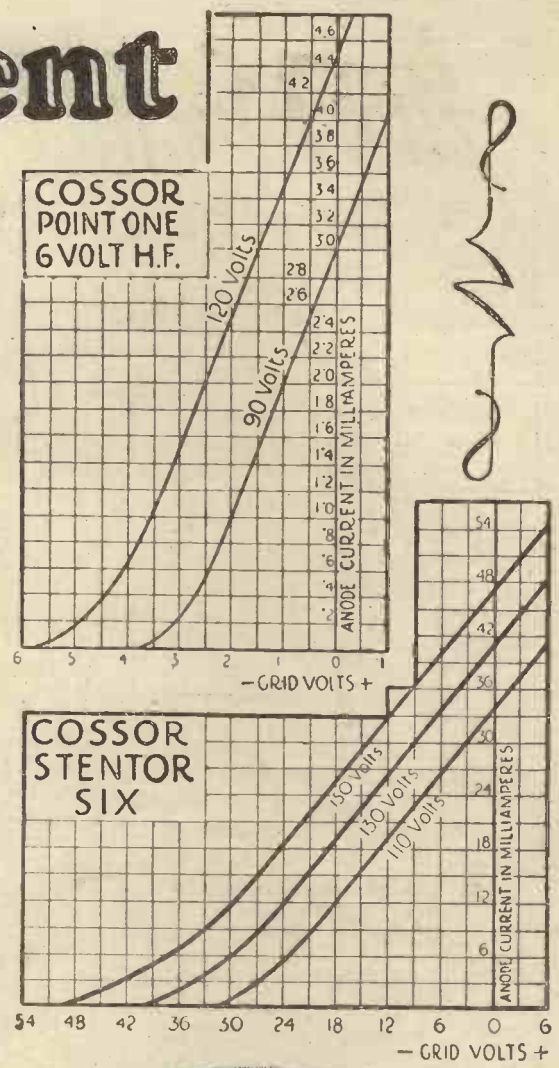
Issued by A. C. Cossor, Ltd., Highbury Grove, London, N.5.

Achievement

UNFETTERED by any electrical or mechanical limitations this wonderful new series of Cossor 6-volt valves give a volume and a richness of tone never before achieved in Radio. Experts have been amazed at the rare beauty andpower — the vitality and mellowness of broadcast music which these valves can create.

And small wonder — for Cossor, after the three years spent in bringing the Cossor Point One 2-volt Valve to an extraordinary degree of perfection, comparable only with valves of higher voltage, now brings to the six-volt field a wealth of experience and technical skill.

Cossor 6-volt Valves are unique in every way—and as such they set new standards of performance. All records for volume, purity of tone, and sensitivity have been broken. Hearing is believing! Let your Dealer demonstrate them to you to-day. For you must hear to realise to what heights of realism Radio music has now attained.



Every valve has a Kalenised filament

A LARGE share in the success of these amazing valves must be placed to the credit of the Kalenised Filament. Operating without visible glow—yet giving off a perfect torrent of electrons—the Kalenised filament is revolutionising Radio. It has cut to shreds the previous high costs of Receiving Sets maintenance. Half a dozen of these new Cossor Six-volt Valves cost less to run than one bright emitter. And because it operates practically without heat, its life is immeasurably longer.

Finally, do not forget the famous Cossor aeroplane test, when a dozen Cossor valves were hurled 500 feet from an aeroplane without harm to their Kalenised filaments.

Only a high emission — coupled, of course, with perfect control—can give volume and natural reproduction. The Kalenised filament gives off an emission unequalled in its intensity—that is why these new Cossor Six-volt valves attain such a remarkably high standard of efficiency.

Compare these curves:

IF you cannot try out a Valve, the next best thing is to study its curve. The curves shown here speak for themselves. Note, for example, the steep slope of the H.F. valve—clear proof of its ability to handle weak signals from distant stations. Compare also, the curve of the wonderful new Stentor Six—observe how well it can cope with the large changes of grid voltage without distortion. As a super-power valve the Stentor Six is without equal. And finally, remember the prestige enjoyed by Cossor valves. Every experimenter speaks well of them. Their long service and low current consumption—their superb tone and high standard of efficiency have won a great reputation, which these new valves will considerably enhance.

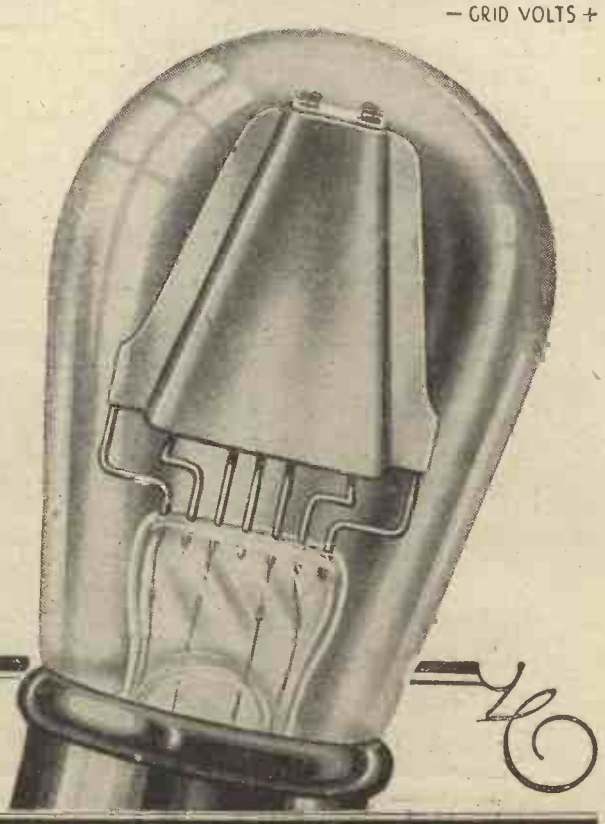
Four types for all requirements:

610 R.C. For Resistance or Choke coupling - - - 14/-
Impedence 80,000 ohms. Amp. factor 50. Consumption 1 amp.

610 L.F. For 1st stage Low-frequency amplification 14/-
Impedeace 8,000 ohms. Amp. factor 8. Consumption 1 amp.

610 H.F. and Det. For H.F. amplification or Detector use 14/-
Impedence 20,000 ohms. Amp. factor 20. Consumption 1 amp.

610 P. Stentor Six Super Power Valve - - - 22/6
Impedence 3,000 ohms. Amp. factor 5·5. Consumption 1 amp.



volt Valves

Gilbert Ad 8408.

Are Portable Sets Worth While?

Some pros and cons of out-door radio

By R. W. Featherstone

WITH the advent of the bright weather comes the annual bright thought, "Why not build a portable wireless set, and enjoy the broadcast programmes out of doors?"

On the face of it, the idea seems a splendid one. The modern set, with its batteries and accessories, is a more or less complicated collection of apparatus, so that in many cases a special set is required for out-of-door work.

Some Pertinent Points

Is the pleasure to be derived from such a set worth the trouble of building it? Is the cost going to make summer radio an expensive luxury? Is the trouble of moving it about from place to place likely to be excessive? These, and kindred considerations, are at present causing many would-be constructors to ask themselves, "Are portable sets worth while?"

There is probably no radio topic upon which a greater diversity of opinion exists! Most *experimenters* are decidedly in favour of out-door radio, contending that not only enjoyment but an immense amount of instruction can be derived in this way. But this verdict "cuts no ice" with the average constructor, who is not out to be instructed in radio problems, but is quite willing to build a set if the results in reception are going to be worth the time and trouble involved.

A good instance of real portability. The attache case contains a complete 2-valve set, with aerial, 'phones and batteries.

It may be said right away that in the set itself there lies no difficulty. The radio art has now advanced to a point where the parts necessary are all robust enough to stand up to transit, and the compactness and portability of components leave little to be desired. As proof of this it is only necessary to cite the example set by those manufacturers who specialise in making portable sets—really excellent instruments—completely self-contained, and working with a volume and clarity that would have seemed unbelievable two years ago.

The Question of Transport

Most of the objections that are raised against out-door radio are raised upon the score of weight, or transport troubles. Such difficulties should never arise. There is no need for them, for the set that cannot be moved easily from place to place is not a "portable set" at all, and all these transport troubles are therefore due to the use of an unsuitable set.

Like all the other branches of radio work, the design and construction of portable sets need a good deal of thinking about—and that thinking ought to be done before a start is made. A little consideration will show that the question of transport is at least as important as the question

Outdoor Entertainment. The set depicted here has a frame aerial fitted inside the lid, but can be used as shown with an outdoor aerial when circumstances permit.

ARE PORTABLE SETS WORTH WHILE?—*concluded*

of the results to be expected from the set.

If you have a car, the transport problem is solved, and the set can be quite an ambitious affair. You can use the car's accumulator for L.T., carry a fairly big H.T. battery and set, and get good loud speaker results without any trouble at all.

A wayside halt to test the screening effect due to a forest.

With a side-car, or a motor-bike, the problems of size and weight have to be considered, and it is better to be content with a smaller set which can be carried easily, than to strain transportation for the sake of getting very loud reproduction. Even with a push-bike the question of portability is not too hard, for a good two-valve set can be packed into an average-size attache case quite easily. 'Phone reception almost anywhere will be excellent, and loud speaker results are not really required, for in such circumstances the loud speaker itself is generally too bulky to take the road.

Small and Light

Where very small batteries must be packed into a case, a one-valve set with 'phones will give splendid service, and, of course, the cost is correspondingly low. Using a valve of the ·06 amp. type, the equipment can be so light that many sets have given successful service upon *walking* tours, though admittedly one has to be an enthusiastic listener if such a tour is to be an unalloyed pleasure.

Little need be said of the advantages of the *really* portable wireless set, as they are too obvious to need mention. Apart from the picnic aspect of it, the portable set is just the thing to keep one in touch with radio during the summer. Moreover, all sorts of interesting stunts can be carried out.

Queer aerials, such as those formed by kite-lines, can be tried out, and the screening effect of hills, forests, etc., can be explored, by the simple expedient of moving the set around the obstruction. In fact, there are endless entertaining possibilities, provided that the constructor is willing to give a little thought to transport, and to the selection of a suitable set.

Temporary Earths and Aerials

Other considerations, such as the earth and aerial, will present no troublesome problems. The aerial can be just a coil of insulated wire—not necessarily the stout, rubber-covered stuff, though this is easiest to use. Good results are obtainable with 18 or 20 enamelled wire, though a certain amount of care is required in the winding and unwinding of this. Slung over a tree by means of a weight on the end, such an aerial will often give wonderfully good results.

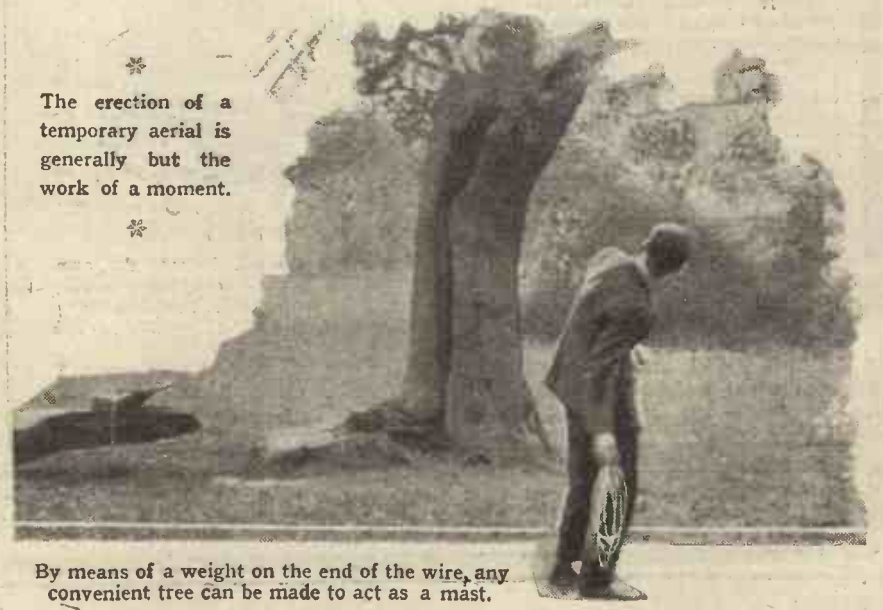
The "earth" is just as easy, and can take the form of a rather thin metal spike, at least 2 ft. long, driven into soil as moist as possible. This spike should be bent at the end, so as to afford a handle by which it can be pulled up easily. When camping near water, a yard or two of bare wire submerged will make quite a good earth connection, especially if the aforesaid spike is firmly attached, and flung in too.

An "Emergency" Set

Experience of past summers goes to prove that there is no real difficulty about portable sets, provided one faces the transport problem from the start, and does not expect the set to develop too much power.

Finally, in weighing the pros and cons, it should be remembered that the construction of a portable set is an excellent way of utilizing spare components. Not only is this a use for parts that would otherwise hang about unconnected, but—and this is an important advantage—it provides a complete stand-by receiver.

The erection of a temporary aerial is generally but the work of a moment.



By means of a weight on the end of the wire, any convenient tree can be made to act as a mast.

RADIO ABROAD

A Monthly Feature Reviewing Wireless Progress in Foreign Lands

By a Special Correspondent

"WIRED-WIRELESS" is a system of sending out radio broadcast but of limiting the broadcast to receiving stations which are connected to the broadcasting station by a conductor such as a telephone line. The transmission is actually by means of wireless waves, but the waves, instead of spreading out in all directions as in ordinary broadcast, are "guided" along the conductors or cables.

You might think that so long as a building was connected by a telephone line there would be no necessity to use wireless waves. But the wireless transmission conducted by the telephone wire does not interfere with the ordinary use of the telephone and, in addition to that, the use of particular lines enables the broadcasting to be made more or less private. It sounds rather a contradiction in terms to speak of "private broadcasting," but it is really broadcasting to selected clients. This type of transmission has been very much developed in the United States during the last two or three years, and is credited to Major-General Squire.

A new company has just been formed, called the Western Ohio Radio Equipment Company, which is an off-shoot from the Sydney Telephone Company; for the purpose of buying, selling, manufacturing, and leasing radio equipment. The company will lease radio outfits to subscribers, which outfits can be operated by them, or it will lease, for a charge of two dollars per month, radio equipment which is operated for the subscriber through the wireless system of the Sydney Telephone Company. On this latter system an attendant will be on duty eleven hours a day—from ten in the morning to one o'clock in the afternoon, and three in the afternoon to eleven in the evening—and the service will be extended after eleven o'clock in the evening if a request is lodged before eight o'clock in the morning. An installation charge of ten dollars is made.

The leasing service has now been in operation for some time, and a considerable number of sets have been installed on this system, which has proved very popular.

Interference

What is believed to be the first case in America where a public service has been found liable for interference with radio reception was recently concluded, when the State Supreme Court upheld a Circuit court jury in awarding 2,000 dollars damages to an applicant in Milwaukee. The claim for damages was started against the Milwaukee Electric Company by the applicant on the ground that a high-tension line near his home made it impossible for him to tune his receiving set properly. The application was in the nature of a test case, and a number of power companies are somewhat anxiously inquiring into the possibility of a crop of further actions of the same kind being brought against them.

Broadcast Development

In an address before the Engineers' Society of Western Pennsylvania, Mr. Merlin Aylesworth, President of the National Broadcasting Company, discussed the development of broadcasting in the United States from a single broadcasting station, with about 700 listeners, six years ago, to over 600 broadcasting stations at the present day, with an audience estimated at between twenty and twenty-five millions.

A "Nutshell" seaplane set. Evolved by the U.S. Navy, this set weighs only 8 lbs. It has a range of several thousand miles.

After discussing various matters connected with broadcasting and broadcast reception, Mr. Aylesworth turned to certain technical difficulties which still require solution. One of the puzzling phenomena which he mentioned was the fact that, on short-wave transmission, reception was sometimes quite good at a distance of a thousand miles from the broadcasting station, and was impossible at a much smaller distance, such as a hundred miles. Great progress had

(*Continued on page* 412.)

IMPORTANT ANNOUNCEMENT!

The CYLDON Research Dept. have produced an entirely new type of Variable Condenser named

THE CYLDON LOG MID-LINE

This new condenser is a great advance over all others, and easily surpasses in performance the Square Law and Straight Line Frequency types.

It is designed on the

LOGARITHMIC PRINCIPLE

The shape of the vanes is approximately between square law aud straight line frequency.

When multiple tuned circuits were first simplified by the ganging of condensers, the square law pattern was the nearest approach to perfection, but we realised that the tuning was limited to a portion of the scale. At each end was silence due to the out of balance, owing to the shape of vanes following a straight line wave-length curve.

Our research dept. immediately tackled the problem, and after many months' extensive experiments, we produced a new shape vane following a logarithmic law, which has very decided advantages over all other condensers.

With these new Condensers tuned circuits are balanced over the entire scale.

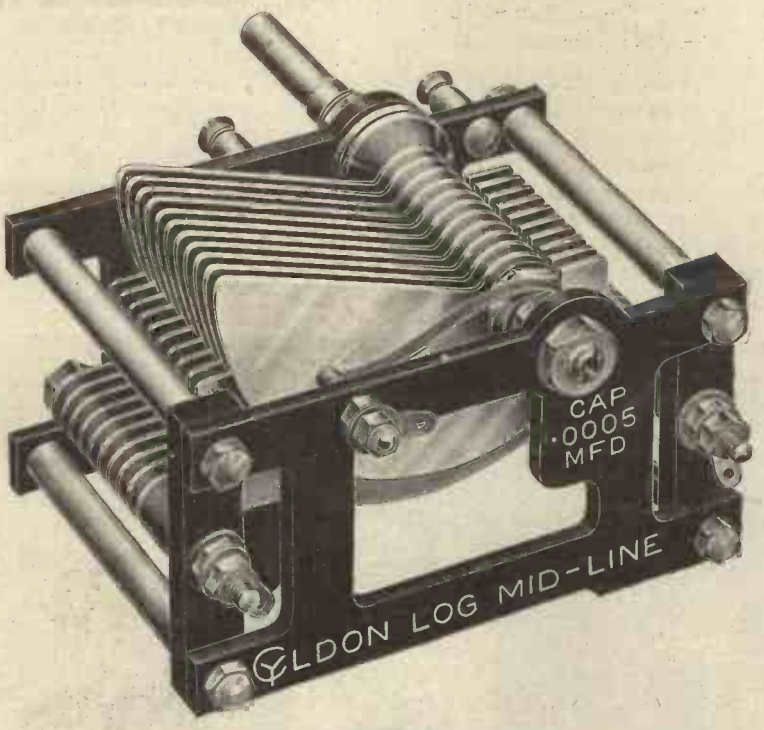
In multi-tuned circuits, all dial readings are identically the same, when two or more condensers are in use.

Stations are much more evenly distributed over the whole scale.

THIS NEW CYLDON ACHIEVEMENT IS THE FIRST VARIABLE CONDENSER MADE IN THIS COUNTRY ON THE LOGARITHMIC PRINCIPLE.

Constructors who have gang condensers of the square law pattern will appreciate that this new advance in design was not foreshadowed until the advent of gang circuits, and we think they will appreciate that as the science of Radio progresses, new inventions must necessarily come.

This new condenser is such a great improvement that in future all our gang condensers will be built up with Log mid-line units. They are the latest and greatest advance in condenser design, and there is not the slightest doubt that the Condenser of the future will be the Cyldon Log Mid-Line.



PRICES:

·001	21/-
·0005	17/6
·0003	16/6
·00025	16/-
·0002	15/6

With 4 in. Knob Dial. If dial is not required, deduct 2s.

NEVER MIND WHAT YOUR CIRCUIT IS—GET

CYLDON

(pronounced Sil-don.)

LOG MID-LINE CONDENSERS

From your dealer or direct from :—

SYDNEY S. BIRD & SONS

Cyldon Works, Sarnesfield Rd., Enfield Town, Middlesex

Telephone: Enfield 0672.

CYLDON

TEMPRYTES

THE BEST MEANS OF VALVE CONTROL. PRICE 2/6 EACH. MOUNTING 1/6 EACH

FULL PARTICULARS & VALVE CHART FREE ON REQUEST

RADIO ABROAD—*continued*

also been made, he said, in the control of static disturbances and interference generally, but the mystery of "fading," or the sudden variation of signal strength sometimes noted in radio reception, had not yet been successfully probed.

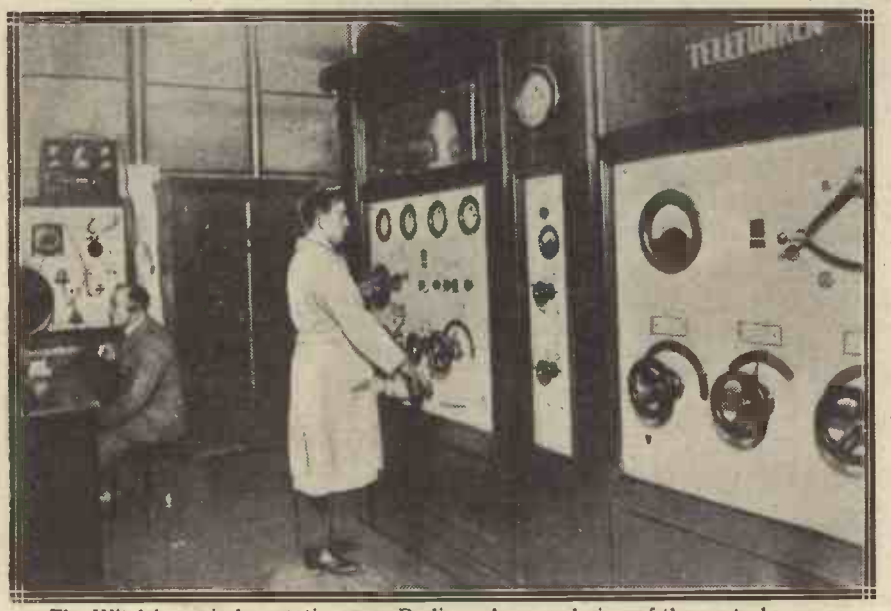
Television Progress

The phenomenal progress made in radio photography in recent years, Mr. Aylesworth said, had brought radio television at least within "thinking distance."

Laboratory developments would soon demonstrate that photographic images could be transmitted in a matter of seconds, rather than in minutes, as formerly. After discussing the wonderful possibilities associated with television, the speaker concluded with the words: "But here you will have to paint your own picture, dream your own dreams, choose your own seat by the fireside-screen, and receive the programmes of a 'sight-and-sound' which some day the National Broadcasting Company, in co-operation with its associates in the electrical field, may develop."

The references to television in the foregoing paragraph remind me that some very extraordinary results have lately been achieved by Dr. E. F. W. Alexanderson, the famous engineer of the General Electric Co., of Bridgeport.

There are several names now well known in connection with the development of photo-radio transmission and television, of which probably the best known in this country is that of Mr. John L. Baird, and on the Continent Monsieur Belin, of Malmaison, near Paris; and in America, Jenkins, Bell, and now Alexanderson. The latter has joined forces with the television pioneers only comparatively recently, perhaps a year or so ago, but in that short time he has succeeded in evolving a system which, whatever may be its possibilities as applied to television, certainly gives results of outstanding merit when applied to "photo-radio," or the transmission of pictures by wireless.



The Witzleben wireless station near Berlin. A general view of the control room.

Use of Oscillograph

The basis of Dr. Alexanderson's system is the use of an oscillograph, by means of which a beam of light is made to flash, many times per second, upon a sensitive photo-electric cell. In the earlier experiments it took twenty minutes to transmit a picture of about 20 square inches area, or one square inch per minute. Alexanderson has now made such progress that he can transmit a picture of 16 square inches area in one minute; that is about 16 times as fast as formerly, and what is perhaps even more important, the picture when received bears an excellent likeness to the original.

Alexanderson's reputation as a radio engineer is world wide, and amongst his achievements may be mentioned the use of wireless valves in radio-frequency amplification and in radio-telephony, the introduction of a practical source of high-frequency energy for radio telephony and telegraphy, and his more recent and well-known work on the polarisation of wireless waves and on the behaviour of polarised waves in transmission.

Speeding up Transmission

According to reports received from the United States, it appears that, although Alexanderson is not making any great promises as to the possibilities of the application of his photo-radio system to television, the possibilities are in fact very important. It appears that in order to apply the system to actual "seeing by wireless," it is necessary to speed-up the transmitting process about 2,000 times, and this, of course, is a matter involving much ingenuity, skill and patience.

New Valves

The Q.R.S. Music Company of Chicago, Ill., announce what they call a "revolutionary step in radio history," which takes the form of a gas-filled rectifier tube which is capable of delivering up to 300 milliamperes at 300 volts. This valve is the result of two years of intensive laboratory experiments, and is claimed to be a complete solution of the A, B and C power supply problem; it eliminates all batteries and all a.c. hum in any set up to ten valves.

Clear Glass

Another interesting valve has just been put out by the Zetka Laboratories., Inc., of Newark, New Jersey, and is known as the clear-glass tube; the clearness of the glass bulb is obtained by means of a patented new process for the evacuating of the bulb. In an ordinary valve the final stages of the evacuating process involve the vaporising of some substance known as a "getter," which is usually metallic magnesium. In this Zetka valve, however, this process is not used, and the result is that the bulb is as clear as that of an ordinary electric lamp. The valve is rated for a plate voltage of 22½ to 250 volts.

Listening to One's self

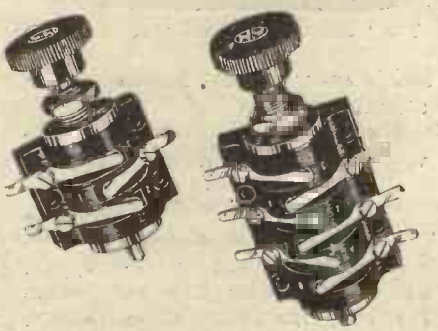
An interesting example of listening-in to one's own performance comes from Baltimore, where a well-known

(*Continued on page* 444.)

In Our Test Room

McMichael Switches

MESSRS. L. MCMICHAEL are producing some very excellent apparatus these days. For instance, we have before us some new M.H. switches which are as good as anything of their kind we have ever seen. They are of the push-pull type but have self-cleaning contacts securely mounted and well spaced. The whole design of these switches is on very robust lines, and such that the articles should give good service almost indefinitely without the slightest attention. The movement is smooth, definite, and there is no "play" whatever in the working parts. The knobs are large, and the single mounting nut is also of respectable size, and is very keenly threaded. Various types are available covering practically every requirement.



Two of the new M.H. switches.

Stewart Loud Speaker

The Cooper-Stewart Engineering Co., Ltd., of Stewart House, Long Acre, London, W.C.2, well known for their famous speedometers and other motor accessories, recently sent us a sample of a new loud speaker they intend to place on the market. The most striking feature of the instrument is its weight—it is undoubtedly one of the heaviest loud speakers we have ever had to lift! But this can, of course, be an advantage from more than one point of view. This speaker certainly does not tend to dance about when subjected to heavy inputs in the manner of some lightweights of the species we have examined! The Stewart loud speaker is enclosed in a substantial metal case which is artistically moulded and coloured a neutral tint which should fall in with practically any scheme of decoration.

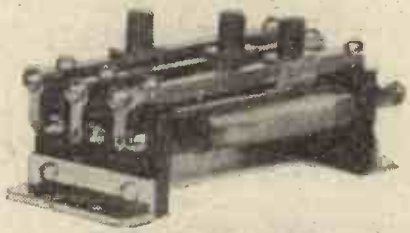
The Stewart Loud Speaker.

It is undoubtedly a handsome article, although probably Chelsea would be divided as to the merits of the "relief" work which appears on it. Nevertheless, there can be no two opinions as to the striking effect obtained, and this is even emphasised by the rather sombre colouring.

On test the Stewart speaker gave very good results. Reproduction was full and mellow, and despite the fair sensitivity of the instrument, there was a commendable absence of resonance. It was able to handle quite low notes without a suppression of the higher frequencies—something of an achievement these days when it seems that we must either have the one or the other but never both! We understand that the price of this speaker has not been definitely fixed yet, but that it will be in the neighbourhood of five guineas.

A Novel Resistor

Although a more or less fierce controversy appears to be raging as to whether or not the filament rheostat is obsolete, the fact remains that barretors, resistors and "variable fixed" resistances continue to pour on to the market. But is not the arrival of the "variable fixed" a step backwards towards the rheostat? Anyway it is undoubtedly a compromise. But a component of this nature needs to be handled with discrimination, otherwise it can be accused of possessing many of the so-called evils of the rheostat.



Messrs. Stapleton's "multi-variable resistor."

A "variable resistor" of a useful and novel design is due to Messrs. A. W. Stapleton of 19A, Lorrimore Street, London, S.W.17. It is known as the "Loriostat" and is designed to serve several valves and provide independent current control. In effect it consists of several resistors built into one compact unit, although "single way" "Loriostats" are available at 2s. each for use with single valves. The range is complete up to a "six way" at 10s. 9d.

The device is very neat and operates very effectively, and it is a convenient little article to dispose of on a baseboard. Each of the several types are obtainable with 6, 15 or 30 ohm maximum resistances.

IN OUR TEST ROOM—*continued*

Atlas Centre-Tapped Coils

Messrs. H. Clarke & Co., Ltd., of Manchester, recently sent samples of some centre-tapped plug-in coils that they have recently placed on the market. These coils are identical in general design to the standard Atlas coils, but are provided with tappings at their electrical centres. They are for use in aerial circuits in order to improve selectivity the centre tap being for the aerial connection. They fulfil this purpose very adequately, and are to be recommended to the attention of all readers who employ single circuit aerial tuning arrangements. Three sizes

An "Atlas" centre-tapped Coil

are available, viz., 40, 60, and 200 turns at 4s. 3d. each the first two, and 6s. 6d. for the No. 200.

An Efficient L.F. Transformer

The B.B.C. transmissions are invariably deliberately distorted in order that the average receiver can reproduce a fairly comprehensive range of audio-frequencies. For this reason *perfect* reception would not prove quite as satisfactory as many might consider. Under such conditions it would be discovered that the transmission was imperfect! Owners of big R.C. amplifiers and cone loud speakers are sometimes annoyed by the emphasis of the low notes which, even though very well received, are generally out of proportion with the higher registers.

For local station reception one good stage of transformer, coupled L.F., will invariably give a performance of a very pleasing nature, and in view of the undoubted advantages of this system it is unlikely that the L.F. transformer will become obsolete for some time yet in favour of resistance capacity coupling. One stage of R.C. is practically useless for loud speaker work, even with the best of high "*mu*" valves, and 120 volts or so is a minimum anode pressure for R.C. purposes. On the other hand, one transformer stage is all that thousands of listeners employ, and many obtain very fair results with H.T. voltages as low as 72.

But a bad L.F. transformer is a very evil thing, and for a long time radio, from a music lover's point of view, was regarded as worse than an early phonograph, mainly owing to the use of poor transformers inefficiently arranged. Nowadays, however, we have some really first-class, scientifically designed L.F. transformers on

A B.T.H. L.F. Transformer

the market. For instance, we were recently sent two B.T.H. L.F. transformers for test. They are of the enclosed type, and their windings are so disposed that their coupling efficiencies are high while their self-capacities are low. Their primaries have ample inductances.

On test we obtained excellent results with the 4–1 in a single stage, and when it was used in conjunction with a stage of R.C., energy transference was good, and there was inappreciable frequency distortion on any but the very lowest register.

These B.T.H. transformers are very distinctive in appearance, and despite their undoubted efficiency are quite compact. Their price, 17s. 6d. each, is, in our opinion, very reasonable.

A "Binocular" H F. Choke

The Climax people have recently produced an H.F. choke which is designed on the "binocular" principle. The component employs two formers, each of which carries an eight-section winding. The two windings are so disposed that their external fields are severely restricted.

The self-capacity of this Climax choke is very low, although its inductance at average broadcast frequencies is of the order of 100,000 mfds. Thus it is capable of efficiently carrying out its duties over a wide band of wave-lengths.

We have introduced this new component into several circuits, both of straightforward and special characters,

The "Climax" Binocular H.F. Choke

and in every case the innovation was attended with very good results.

We consider the price, 8/6, to be very reasonable in the circumstances.

Cheap Valve Holders

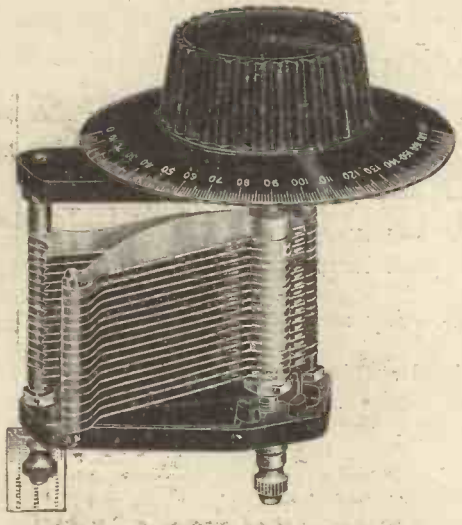
Messrs. Cason Mouldings, 1, Lansdowne Road, Hackney, London, E.8, are manufacturing two very cheap baseboard mounting valve holders. They are compact, well-designed little components, and are both "low loss" and antimicrophonic in pattern. They appear to be very well made, too, and how the manufacturers are able to market them at retail prices of 6d. and 1s. each we can hardly understand. The 1s. model is almost "de luxe," and represents as good value for money as any radio component we have had pass through our hands this, or even last year.

Wet H.T. Innovations

The Eton Glass Battery Co., of 46, St. Mary's Road, Leyton, E.10, have sent us samples of their new H.T. battery cells. These cells are modelled exactly on the lines of the large standard Leclanche cells and similarly to these have tiny little porous

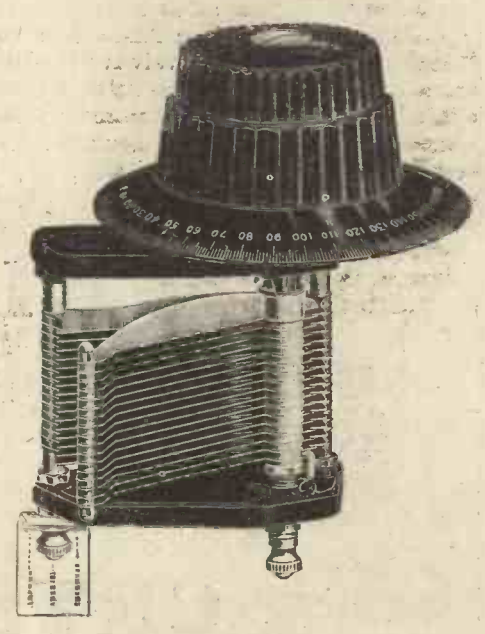
(*Continued on page* 448.)

a 1st class Ormond SLF condenser for 5/6!



—*The Ormond "No. 3" S.L.F. Condenser*

Ormond are already famed in every quarter of the globe for their apparently unique ability to combine first-class British workmanship with bed-rock prices, but here is a new Ormond Variable Condenser that will entirely revolutionise all existing ideas of Condenser values. This new Ormond "No. 3" S.L.F. Condenser is in every way a typical Ormond product — highly finished, highly efficient. The demand for it, needless to say, will be tremendous.



The new ORMOND "No. 3" S.L.F. CONDENSER is the precision Straight Line Frequency condenser with a greatly reduced frame and highly finished Bakelite end plates.
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A BRITISH PRODUCT—BETTER AND CHEAPER

A Simple Lever Switch

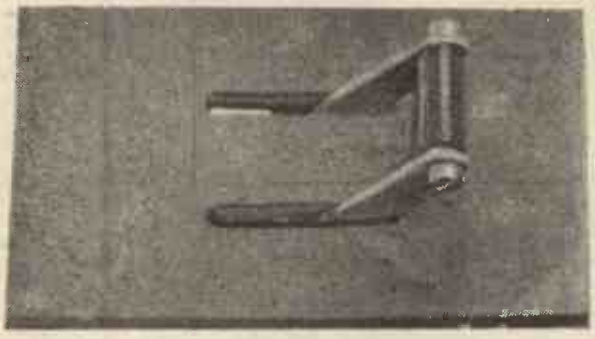
FROM A CORRESPONDENT

THOSE who like to make with their own hands as many of of the parts of their receivers as possible, will be sure at one time or another to need switches. The present-day tendency towards the use of fixed filament resistors, or baseboard mounting rheostats, set to the correct value and then left alone, involves the incorporation in the design of the receiver of an on-and-off switch for the filament battery. The switch is rendered still more useful if it switches the H.T. battery on and off as well.

Switching Both Batteries

A neat switch to combine these two functions in one movement can be made quite easily. The accompanying diagram shows that in the switch described two parallel arms are all that appear on the front of the panel, the "works" of the switch being inside the cabinet. Little panel space is taken up, and rubbing contacts ensure that the switch blades will keep themselves clean.

To make a neat job of the switch requires careful work, and if the constructor doubts his ability to build it up straight on the panel of the receiver, the best plan will be to mount the parts on a piece of $\frac{3}{16}$ in. or $\frac{1}{4}$ in. ebonite of the dimensions given in the diagram. Then slots may be cut in the panel for the levers to pass through, the piece of ebonite being fixed with screws behind the panel. In this way any errors in drilling and so on will not damage a large panel.

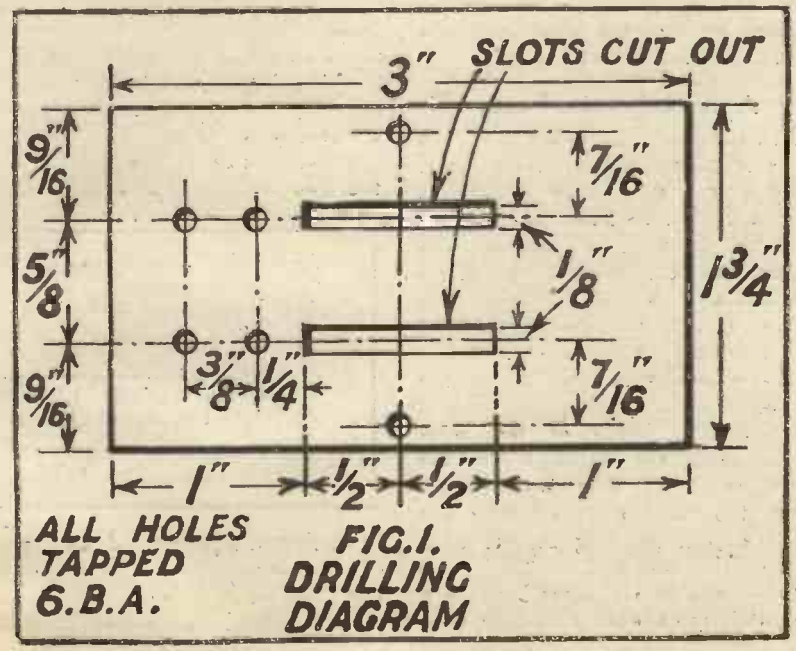


This view of the front of the switch shows that it takes up very little panel space. If desired, it may be mounted direct upon a small sub-panel.

For the purpose of this description it will be assumed that the switch is being made up on a separate sub-panel. The first thing to do is to mark out this panel with a scriber, in accordance with the drilling diagram given in Fig. 1. The slots are made by drilling a row of holes as close together as possible between the lines marking the edges of the slots. The webs between these holes are then carefully cut away as far as possible with a penknife, till a thin flat file can be inserted and the edges of the slots filed down to the lines.

Tapping the Ebonite

If taps are available, the appearance of the finished switch will look most "professional" if the six holes for the 6 B.A. bolts are tapped out. For this purpose "blind" holes should be drilled, the drill not being allowed to pass right through the ebonite. If preferred, these holes may be drilled 6 B.A. clearance size, bolts with countersunk heads being inserted from the face of the panel, and nuts put on them to hold the parts in position.



A SIMPLE LEVER SWITCH—*continued*

The Metal Strips

For the metal parts of the switch 10½ in. of brass strip will be needed, ¼ in. wide.

Various thicknesses of brass were used for the switch described, depending upon the metal strip on hand, for as long as the spring contacts and angle-brackets are at least ⅛ in. thick, the exact gauge is immaterial. Anything thinner than this will not make a sound job. The lever arms should be thicker; in fact, the thickness of ⅛ in. specified is the thinnest that will be satisfactory here. Actually the writer used copper strip for the lever arms, and brass for the remainder, these materials happening to be handy in convenient form.

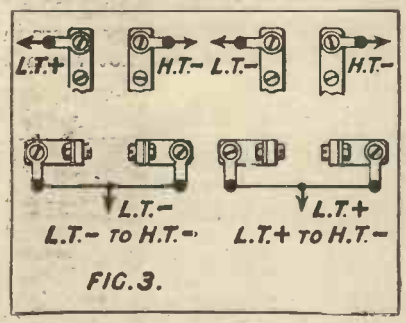


FIG. 3.

The two holes in each of the spring contacts should be drilled before any bending is done. Be careful to get the holes in the centres of the strips, and file away any burr before mounting them. Great care should be taken in the bending to make the two contacts exactly alike, since failure to do this may lead to an imperfect contact on one half of the switch. For the same reason the holes in the vertical members of the angle brackets must be accurately centred. The corners of both ends of the lever arms are rounded off with a file.

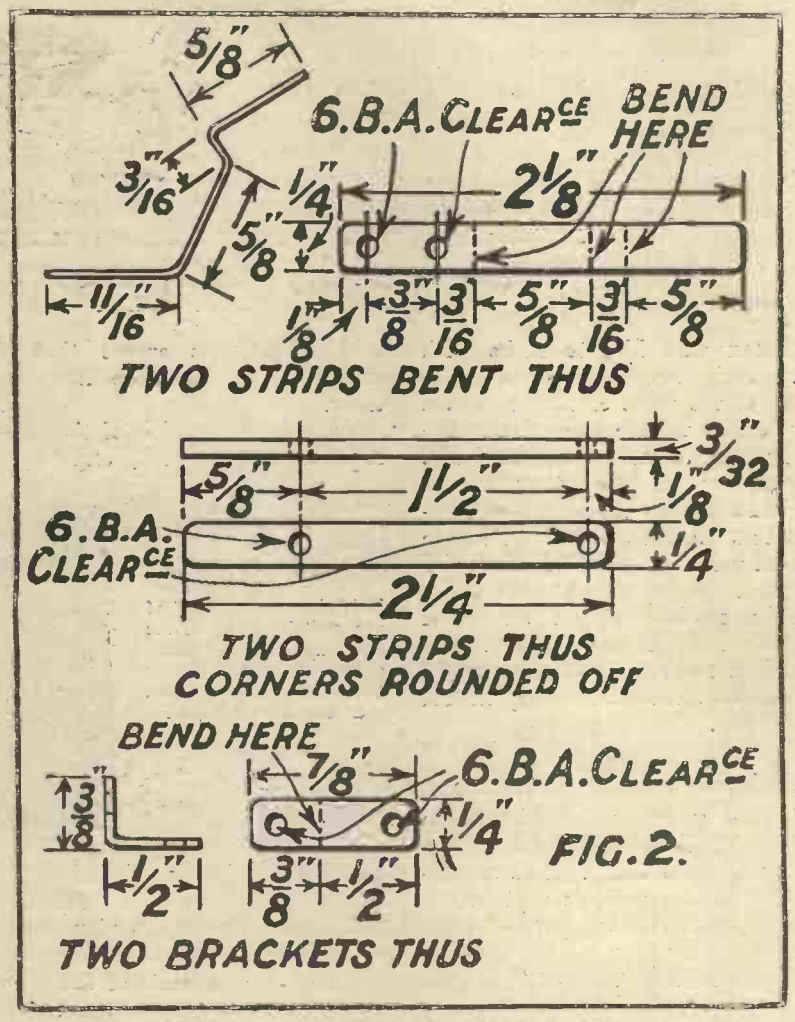


FIG. 2.

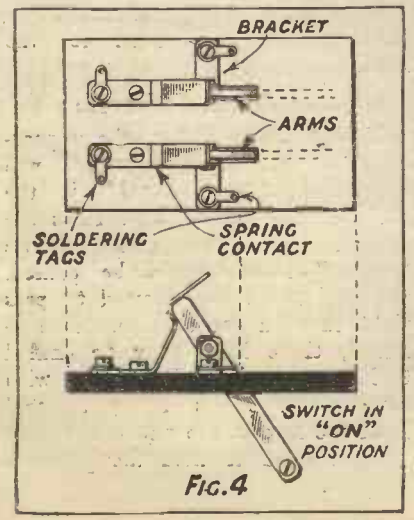


FIG. 4

Assembling the Parts

In assembling the switch the first parts to mount are the lever arms. Each arm is secured to its bracket with a 6 B.A. bolt and nut. Locknuts may be used to keep the bolts secure, but it is simpler to put on one nut only, adjust it till the arm can move freely but without shake, and then with a hot iron to apply a blob of solder to the nut and the end of the bolt.

Under the heads of the bolts which hold the brackets to the panel, soldering tags are placed. Note, too, that soldering tags are fitted on one securing bolt of each of the spring contacts.

When springs and arms have been mounted, press each arm into contact with its spring and see that it makes a good firm contact and goes right home into the angle of the spring. Also see that the arms can move freely to and fro in the slots. Slight corrections can be made by bending the springs or filing down the ends of the arms.

It remains to fix the link between the two arms which enables them to be moved together. A short piece of ebonite rod is used for the crossbar, tapped out for 6 B.A. bolts at each end. If one side of the switch

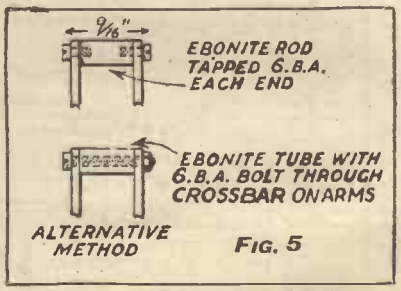


FIG. 5

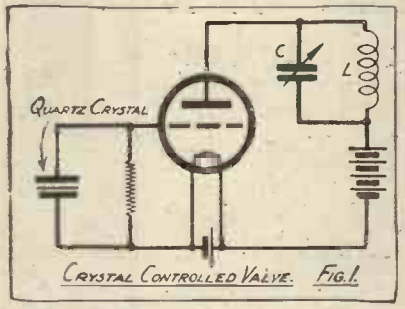
(*Continued on page* 438).

Piezo-Crystals and Selective Reception

A suggestive article which should make a strong appeal to every experimenter.

By
RAYMOND SLOANE

BROADCAST uses of piezo-electric crystals for stabilising the frequency of carrier-waves have been attended by great success. In such cases the fundamental frequency of the oscillating crystal is utilised as a direct master-control to maintain the emission from a valve oscillator at a constant and steady value.



CRYSTAL CONTROLLED VALVE. FIG. 1.

The problem of selective reception is, however, just as pressing as that of regulating the frequency of the various Broadcast stations, and it is important to consider the possibilities of using a quartz or other crystal oscillator in this connection.

How the Crystal Operates

In the first place it will be helpful to examine the precise behaviour of a piezo-electric crystal when inserted in the grid circuit of a valve oscillator as shown in Fig. 1. If the circuit C L is tuned to the same fundamental frequency as that of the crystal, the valve will oscillate steadily at that frequency. Should the tuning of the plate circuit now be altered, even within comparatively narrow limits, the valve ceases to oscillate.

Suppose the condenser C is set at the correct value for self-oscillation. As the high-tension is plugged in, a surge of current passes through the valve, the oscillatory component of which energises the circuit C L. The resultant voltages set up across the coil L are conveyed through the capacity coupling inside the valve on to the face of the crystal.

Owing to the piezo-electric action, the effect of the first applied voltage will be to compress the crystal from its normal shape, shown in full lines, to that shown in dotted lines in Fig. 2A. The crystal is then charged positively on its upper face and negatively on its lower.

The deformation of the crystal is due to the applied voltage. In 1880 the Curie Brothers first discovered that if the crystal was subjected to mechanical pressure, it contracted as shown, and simultaneously developed a charge across its surface. It was subsequently found that an applied voltage conversely gave rise to a bodily contraction of the crystal.

A Charge Reversal

The contraction shown in Fig. 2A is only temporary. Natural elasticity at once comes into play, and in the effort to regain its original shape, the crystal overshoots itself as shown in dotted lines in Fig. 2B.

With the alteration from compression to dilation, the charge across the face changes in sign as shown, the upper face now carrying a negative and the lower a positive charge. The next movement again overshoots the normal and reproduces the conditions shown in Fig. 2A.

The bodily vibration of the crystal is now in accord with the voltages impressed upon it from the plate circuit, and the surface-charges produced by the piezo-electric effect are at their maximum.

These charges are communicated to the grid, and impulse it in the same manner as if the crystal were replaced by a tuned electrical circuit, thus setting the valve into sustained oscillations.

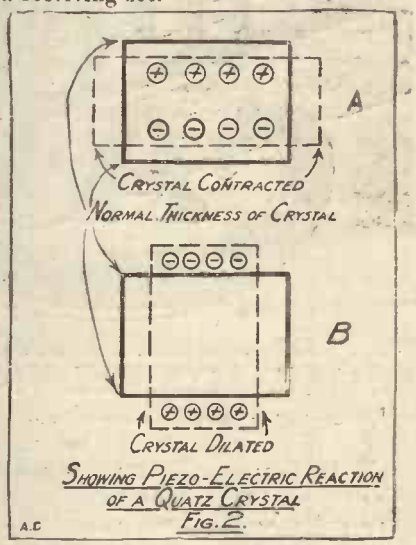
If the plate circuit is now mistuned, the crystal acts merely as a high capacity reactance, and the peculiar piezo "back e.m.f." is practically lost. At all events it becomes insufficient to stimulate the grid to the degree necessary to maintain the valve in steady oscillation.

A Recent Patent

It must be clearly understood, therefore, that a quartz oscillator will only react vigorously to an applied voltage when the latter has a frequency corresponding to the natural frequency of the crystal. Impulses applied at any other frequency have little or no piezo-electric effect.

Such a crystal, if utilised as an intervalve coupling, can accordingly be arranged to transfer a particular selected frequency, and to cut out the effect of all other frequencies.

Fig. 3 shows an arrangement recently protected by the Metropolitan Vickers Co., in which the action of a piezo-electric intervalve coupling is utilised for securing an extremely high order of selectivity in a receiving set.



SHOWING PIEZO-ELECTRIC REACTION OF A QUATZ CRYSTAL FIG. 2.

The crystal Q is inserted in shunt across the tuned plate circuit L C of a H.F. amplifier A. If the quartz has been cut to the carrier-wave frequency of a selected transmitting station, then only the signals from that station will be communicated to the grid of the valve B.

Other frequencies which may be present in the plate circuit of the first valve cannot produce sufficient piezo-electric reaction across the crystal to affect the grid of the second valve. Any such interfering signals are accordingly prevented from reaching the phones.

On the other hand, the selected frequency will set the crystal into oscillation so as to produce a vigorous reaction voltage, which is in turn thrown on to the grid of the valve B.

(Continued on page 424.)

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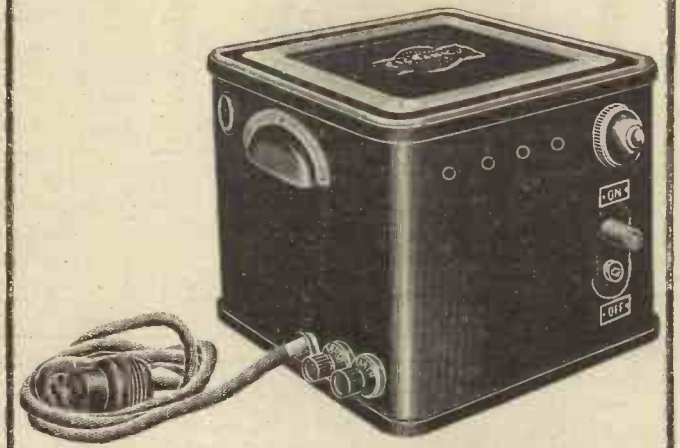

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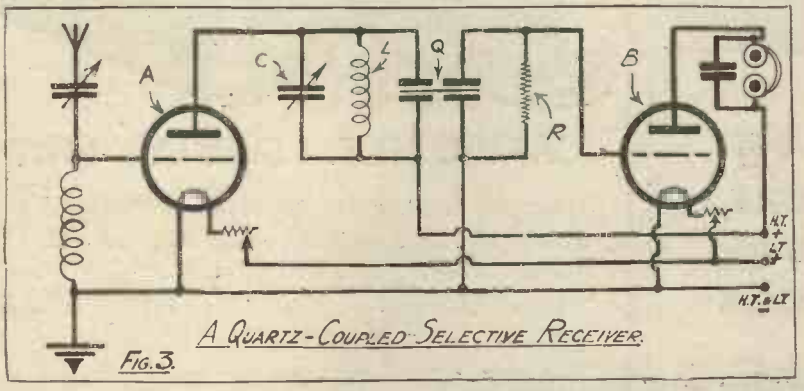
PIEZO-CRYSTALS AND SELECTIVE RECEPTION

—concluded from page 422

The high resistance R shunted across the crystal in the grid circuit of the second valve, acts in combination with the capacity of the crystal-mounting as an ordinary grid condenser and leak to give signal rectification.

Expensive—At Present

By selecting a series of quartz crystals cut so as to oscillate at the carrier-wave frequency of a number of different Broadcast stations, and inserting one or other of the crystals in circuit as required, the ideal of perfect selectivity should be achieved.



A QUARTZ-COUPLED SELECTIVE RECEIVER.

FIG. 3.

There are, of course, certain objections to be considered in practice.

The first is really the matter of expense. Cut crystals are at present a somewhat expensive luxury, due largely to the comparatively limited demand for them. Given a new and wider field of utility, means will soon be found to reduce their cost.

Another Drawback

The second objection arises from the well-known fact that when selectivity is pushed too far, the quality of reproduction is necessarily lowered. It is essential not only to receive the exact carrier-wave frequency, but in addition to cover those modulation side bands which convey the timbre or characteristic quality of the transmitted sounds.

There are two possible solutions to this difficulty. In the first place, although the frequency response of the crystal is extremely narrow and clean cut, it should be feasible to modify this by damping methods, similar to those used in lessening the selectivity of an electrical circuit tuned by capacity and inductance.

In the latter case the insertion of a series resistance produces the desired result. With a crystal the introduction of a slight amount of friction to its bodily movement is indicated.

This could be effected, for example, by mounting the crystal in a casing filled with liquid, or with air under pressure.

On Short Waves

Finally, it is possible that future broadcasting may be carried out on much shorter wave-lengths than those at present used.

In such circumstances the normal resonance curve of a quartz oscillator will be found sufficiently broad to embrace all those side bands necessary to secure a high level of tone reproduction on the receiving side.

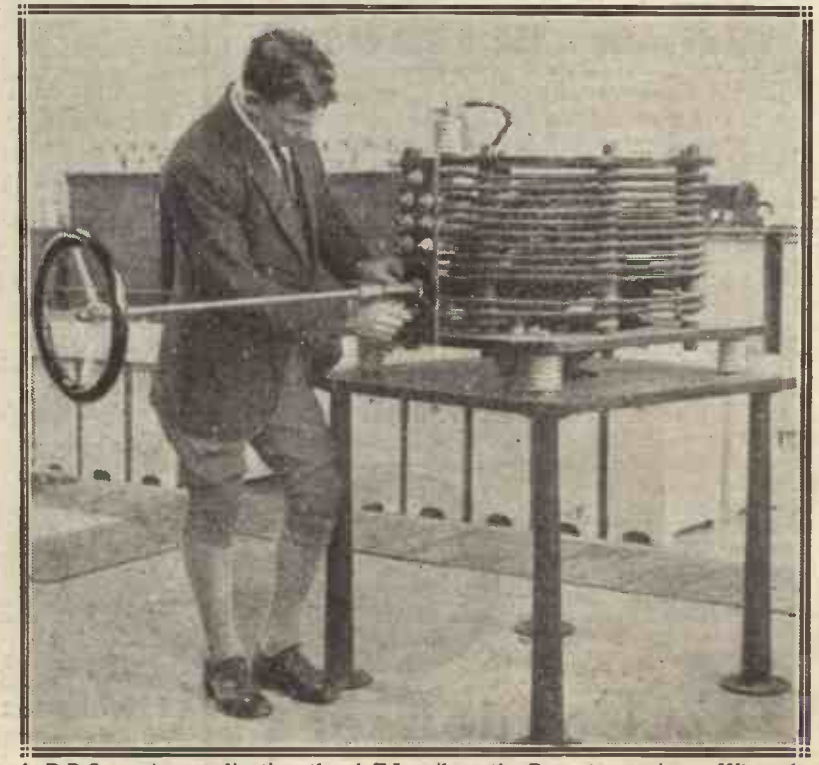
As the "clipping" of side bands causes distortion it is a factor that must be guarded against in all selective systems.

THE APPEARANCE OF YOUR CABINET

RADIO set cabinets which have been elaborately french-polished must under no circumstances be rubbed over with any spirit preparation in an endeavour to preserve and enhance their degree of polish. French polishes are soluble in spirit, and thus a cabinet treated in this manner would very likely be completely ruined in appearance. Use for the purpose a very soft rag which has been just moistened with paraffin oil and a few drops of clean, warm water. Afterwards rub the cabinet down with a perfectly dry soft cloth, and an excellent polish will result.

Oak cabinets are best polished by rubbing them over with a rag moistened with a little *raw* linseed oil, the final polish being given to them by means of a soft, dry duster.

A good polish can be given to cabinets of ordinary wood which have been merely spirit stained in a more or less rough manner by dissolving a small piece of paraffin wax in an ounce of hot castor oil, and by rubbing the cabinet over with a rag which has been soaked in this mixture. Finally, a dry clean rag is rubbed vigorously over the surface of the cabinet.



A B.B.C. engineer adjusting the A.T.I. coils at the Daventry station. When the transmitter is operating the long extension handle must be used for this purpose.

A NOVEL FRAME AERIAL BASE

A Practical Article for the Constructor.

By A. V. D. HORT, B.A.

A TROUBLE that every user of a frame aerial has probably experienced at one time or another is that the leads to it will insist on becoming tangled whenever the frame is used for picking up distant stations. Unless particular care is taken, and if the frame is not turned backwards and forwards through a small arc, but is occasionally turned completely round, the leads become crossed and also usually wound round the base of the frame. Apart from the annoyance that this is liable to cause to the operator, considerable twisting of the leads will introduce a certain amount of additional capacity between the ends of the frame winding, which is undesirable.

Now this difficulty can be surmounted, and the construction of a special base for the frame, which is the subject of this article, is not really complicated. Accuracy of work is necessary if the finished base is to function properly, but the tools required are merely those which every constructor possesses, while a number of the parts will be already to hand in the workshop.

The appearance of the base will be apparent from the photograph and drawings. The frame itself and its winding are not shown here, the designing of these being left to individual taste. The ends of the winding are brought to two spring plungers bearing on two flat brass rings. These rings are connected to two terminals, conveniently placed for attaching the connections from the set. When the frame is rotated the spring plungers maintain constant contact on the brass rings, so that loose leads to the ends of the windings are entirely eliminated and there is nothing to tangle. The leads to the set from the terminals may be rigid, thus making variations at this point impossible.

Few Parts Required

For the construction of the base the following parts will be required: Three pieces of ebonite, one 4 in. by 4 in. by $\frac{3}{16}$ in., another about 3 in. by 1 in. by $\frac{3}{16}$ in., and the third $3\frac{1}{4}$ in. by $\frac{1}{2}$ in. by $\frac{3}{16}$ in.; also a small piece of $\frac{3}{16}$ in. ebonite about 1 in. square.

Two brass rings not less than $\frac{3}{32}$ in. thick, $3\frac{1}{4}$ in. and $1\frac{1}{2}$ in. outside diameter respectively, and $\frac{1}{4}$ in. wide. (Unless the constructor has a lathe, these are best obtained ready cut out. The rings used in the base shown were obtained from Messrs. Beard & Fitch.)

Two complete spring contacts from a standard pattern electric lampholder.

A 5-in. length of 2 B.A. brass rod, six 2 B.A. nuts and two washers, and two spindle bushes of the type used in variable condensers and similar components.

Wooden base 4 in. square and four wooden "pillars," each 2 in. long.

Six 6 B.A. bolts, two terminals, two soldering tags, a short length of Glazite, and a number of wood screws.

Preparing the Brass Rings

The first operation is to mark out the ebonite square for drilling. After finding the exact centre of the square by measurement, with a pair of dividers scribe two circles on the ebonite, $3\frac{1}{4}$ in. and $1\frac{1}{2}$ in. in diameter respectively. Mark also the positions of the holes for the four wood screws at the corners of the square. The next thing is to mark the holes on the brass rings. There are three holes in each ring, equidistantly spaced. The correct points may be determined most easily by marking points on the rings 120 degrees apart. When the holes have been marked in this way and punched, they should be drilled with a 6 B.A. tapping size drill, and tapped out 6 B.A., any "burr" on either side of the rings being subsequently filed off. Now the two rings may be laid on the ebonite square, the scribed circles acting as a guide to their exact positions, and the holes marked on the ebonite for the fixing bolts. These holes are drilled 6 B.A. clearance size. A hole of similar size should also be drilled at the centre of the square.

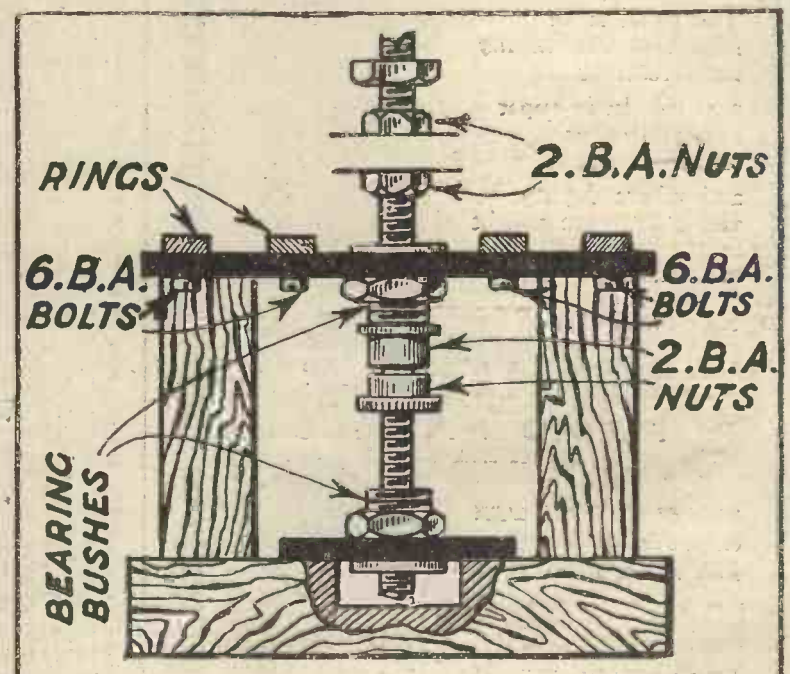


FIG. 1

The frame aerial base in section.

A NOVEL FRAME AERIAL BASE—*continued*

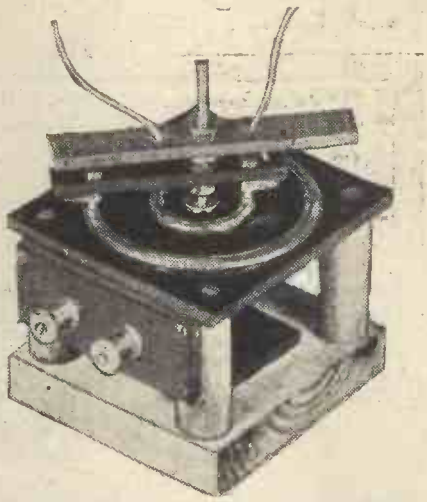
The Wooden Pillars

Lay the ebonite square on the wooden base and make a mark on the wood through the centre hole. At this point in the wood a hole not less than $\frac{3}{8}$ in. in diameter is sunk to allow clearance for the projecting part of the lower bush. This bush is mounted on the small ebonite square, and this is then secured to the wooden base with wood screws, care being taken to see that the centre of the hole in the bush comes exactly over the centre of the hole sunk in the wood.

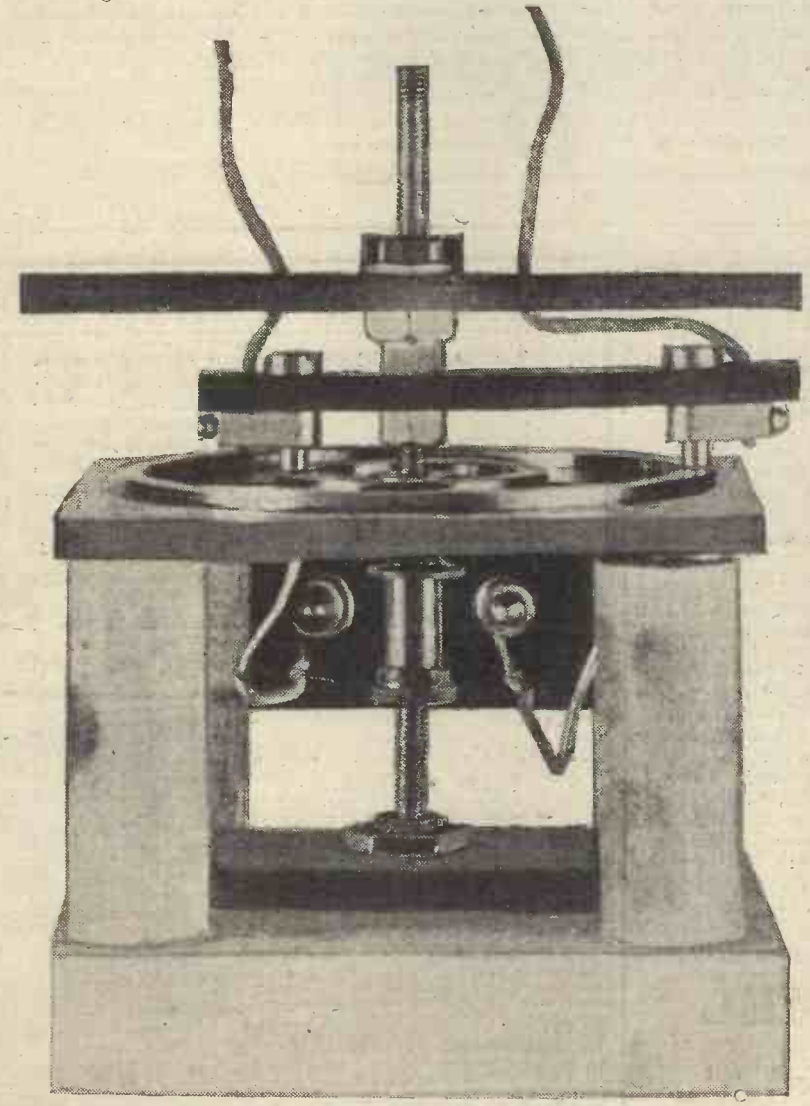
The four wooden pillars supporting the top panel are secured to the wooden base by means of wood screws inserted from beneath the base. The pillars should be at least 2 in. long, as otherwise the two bearings of the main spindle will be too close together, and there may be a certain amount of "shake" in the frame. The rings may now be bolted in position, the small one being fixed first. Six B.A. cheese head bolts pass up through the holes in the panel and into the tapped holes in the rings. Under one bolt-head on each ring is placed a soldering tag. Any projecting part of the bolts above the surface of the rings is then filed off, the surface being rendered as smooth as possible. A final finish to the rings may be imparted by wrapping a piece of emery cloth round a small block of wood and using this as a rubber.

Securing the Panel

The centre hole in the panel should be enlarged with a $\frac{3}{8}$ in. drill, and the top bush inserted. The terminals are mounted on a strip of ebonite, which is secured with wood screws to two of the wooden pillars. Short lengths of wire connect the terminals to the soldering tags when the whole assembly is complete. In securing the panel to the top of the pillars, make certain that it comes exactly over the wooden base, as otherwise the bearings will be out of line.



Another view of the base, showing how the terminal board is fixed to the pillars.



This photograph shows how the two plungers make rubbing contact with the brass rings, and the terminals for connecting the frame to the set.

The carriage for the frame will be quite easily constructed with the help of the drawings. The marking of the positions of the contacts on the ebonite strip must be done accurately, so that the plungers will run on the centre lines of the rings. The carriage should be mounted before the frame is attached. A washer is placed below the top bush, and beneath this again are two nuts firmly locked together. These nuts should hold the spindle down far enough to depress the plunger contacts about half-way, thus ensuring a good firm contact on the rings.

Fixing the Frame

The frame itself is attached as indicated by the short top crossbar in the photograph. It is recommended that the type of frame used with the base should be of the plain square type, with slotted ebonite strips at the corners to carry the winding, as shown in Fig. 2. This type of frame readily adapts itself to the method of fixing available.

(*Continued on page* 430.)

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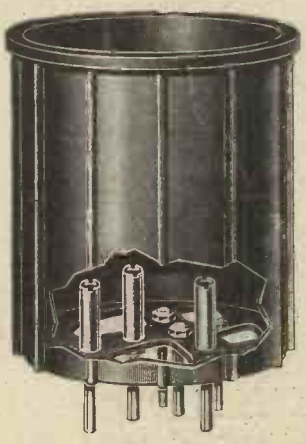

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Read this "It's a revelation"

A letter recently received from a keen experimenter is so packed with interesting points, that we give it in full below.

The "Utility" Micro-Dial
Price 7/6

"Utility" Condensers
Price: .0005 15/-
.0003 14/-
.00025 13/6
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When fitted with this Micro-Dial.
When ordering, the diameter of spindle it is intended to fit should be stated.

"I rigged up a powerful microscope with a peculiar reflecting system which enables me to follow a magnified movement of the rotary plates, and by operating the vernier control minutely, I measured movements of a thousandth part of an inch quite accurately, but of course that alone is not of great value, but I was able to at will return to the original position, by reversing the pressure, backlash being absolutely non-existent: I repeatedly did this, making the movement with perfect ease, from a zero point to minus or plus one thousandth part of an inch. Obviously such a degree of accuracy of control would never be required, but compared with three or four other makes I repeatedly experimented with it is a revelation."

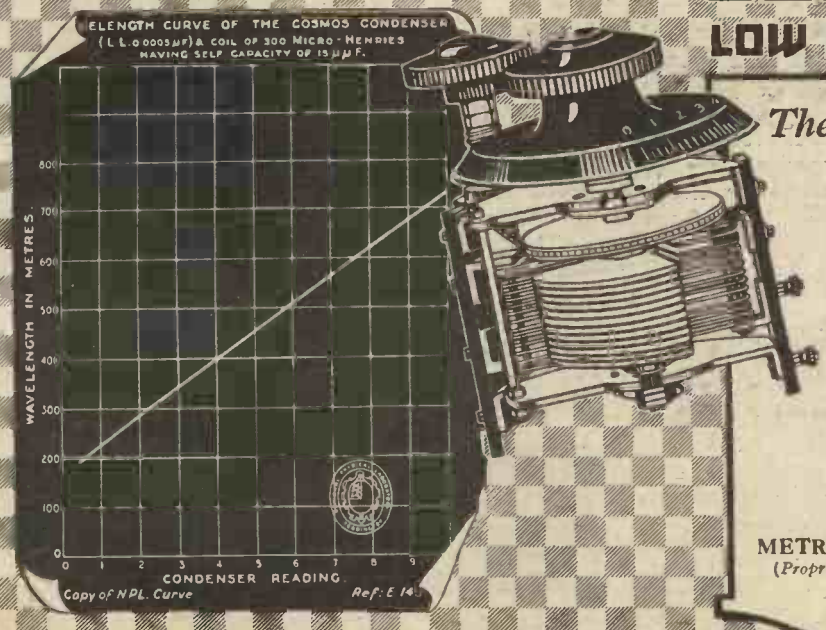
Insist on "Utility" Guaranteed Components

N.B. If any trouble is experienced in obtaining our goods, please communicate with us direct.

WILKINS & WRIGHT LTD
KENYON ST. Utility Works BIRMINGHAM

COSMOS SQUARE LAW CONDENSERS

LOW LOSS SLOW MOTION



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The National Physical Laboratory Curve shown here demonstrates the STRAIGHT LINE characteristics of the "Cosmos" Square Law Condenser. Its other fine points include the permanent absence of BACK LASH, its adaptability for REMOTE OPERATION and its MODERATE COST.

·00025 mfd. **14/9** ·0005 mfd. **15/6**
Without the slow motion device prices are:
·00025 mfd. **12/-** ·0005 mfd. **13/-**

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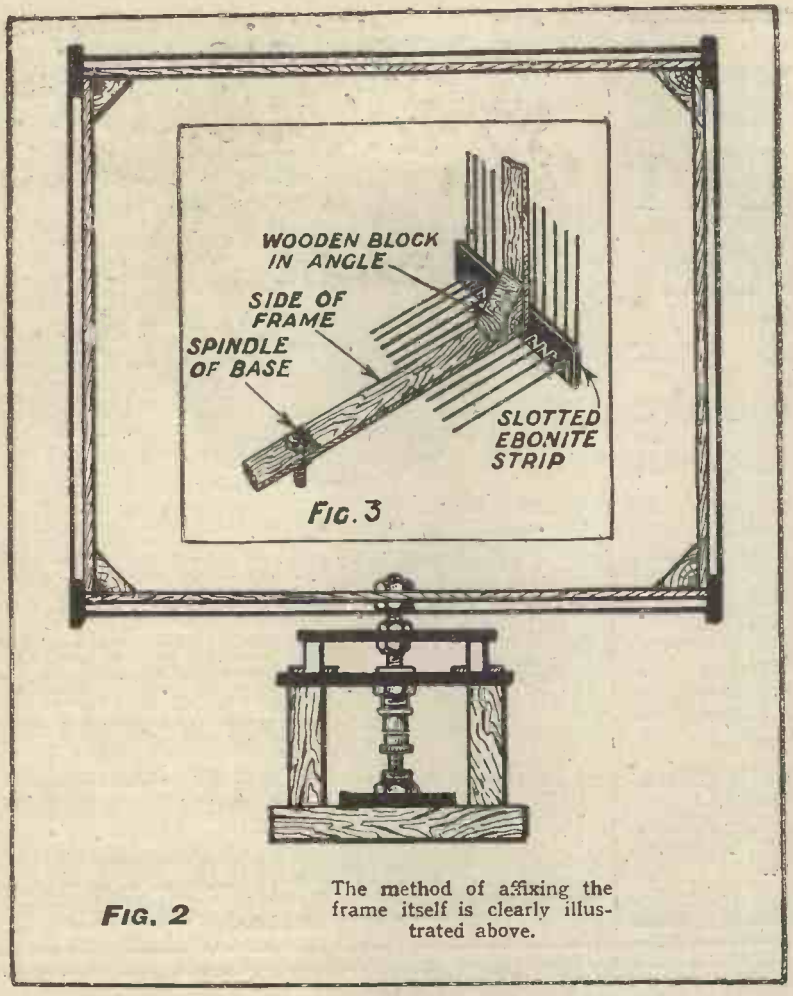


FIG. 2

The method of affixing the frame itself is clearly illustrated above.

A NOVEL FRAME AERIAL BASE

—concluded from page 428.

If the movement is at all rough in use, further applications of the file and emery cloth on the rings should put matters right. Any signs of squeakiness may be cured by smearing a trace of vaseline on the rings, this substance appearing to have no ill effect electrically. If wear takes place at the plungers and the contacts become noisy in use, the nuts below the top bush provide a ready means of taking up the slack.

QUICK RESISTANCE RECKONING

By "AMEC."

ON very many occasions, it is highly desirable for the amateur to be in a position to measure the resistance of various pieces of apparatus, coils, various lengths of leads, and so forth. The resistance-box and Wheatstone Bridge methods of measurement, however, necessitate the employment of costly apparatus which is not generally to be found in the possession of the average radio amateur, whose pocket is usually less extensive than his ambitions.

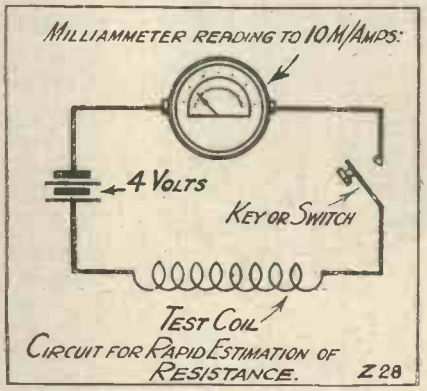
For Rough Tests

However, the following little method is sufficiently accurate to enable a resistance measurement being taken in the minimum of time, and with the minimum of trouble.

To this end, we require a milliammeter reading to ten milliamps., and a 4-volt accumulator, or battery (preferably, an accumulator, on account of the greater constancy of the current supplied by that article).

Connect up the milliammeter in series with the accumulator and the coil or other object the resistance of which is to be measured, and observe the amount of current flowing.

Now, assuming that the current supplied by the accumulator is exactly 4 volts, all we have to do to estimate the resistance of the test object is to divide 4,000 by the milliammeter reading, and the result will be the required resistance in ohms.



For rough tests, this method will be found to be very convenient. However, it is not strictly accurate. For one thing, the accumulator or battery may not supply exactly four volts.

Obtaining Greater Accuracy

Therefore, if results of greater accuracy are required, we must first of all estimate the voltage of the accumulator current by means of a voltmeter. This voltage is then multiplied by 1,000, and this figure is divided by the milliammeter reading. From the result so obtained, we must then subtract the resistance of the milliammeter. This is often printed on the dial of that instrument, but if not, an average of 50 ohms may be reckoned.

An American set which obtains both H.T. and L.T. direct from the mains.

RESISTANCE CAPACITY PROBLEMS

(concluded from page 368.)

to employ in the second holder a valve with a smaller amplification factor which is capable of dealing with a larger grid swing. In fact, if we think the matter over for a moment we see that each valve after the first must be capable of dealing with a bigger grid swing, and this means that we must perforce use valves with smaller and smaller amplification factors in the second and third holders if we are to avoid the hateful distortion that results from overloading.

Concerning the Valves

One solution would be to use throughout valves with smaller amplification factors than those referred to. We should thus be able to receive without overloading the last valve or any other. This, however, is not a satisfactory arrangement, since it deprives us of the big magnification that is desirable when weak and distant signals are coming through.

On the whole the best method is to provide a means of cutting out one valve at will. Now this valve must obviously not be the last, for if we did this we might find ourselves forced to use a power valve in the second holder in order to work a loud speaker on the local station's transmissions without distortion, and few power valves have an amplification factor greater than about six, or, say, an actual amplification of five. If then the last valve were the one to be cut out or thrown in at will we should have a reserve of amplification of only about 5, which would in many cases be too little.

A method which I have found particularly effective is illustrated in Fig. 6. Here V_2 can be thrown into or out of circuit in the simplest possible way. Suitable valves for such a combination are SP55B in the first holder, PM5X in the second, and PM256 in the third. For the local station and other powerful signals the plug is inserted into J_1, whereby the output of the first valve is applied direct to the grid of the third. V_2 is completely cut out and its filament is switched off. For long distance work the plug is inserted into J_2, which switches on the second valve and brings it into action. Since V_2 is a valve with an amplification factor in the neighbourhood of 17, giving an actual amplification of about 12, one thus obtains more than double the reserve of power that is available where the last valve is the only one that can be cut out.

Worth Trying

The resistance-coupled amplifier is well worth the attention of any enthusiast to-day, for thanks to the wonderful work done by valve designers he can now obtain by this means really efficient note-magnification combined with quality that is very little indeed short of perfection. I have probably said enough to show that though any fool can *not* make a resistance-coupled amplifier, the wise man will turn his attention without delay to this most interesting side of wireless.

With careful consideration of valves, resistances, etc., he will be more than pleased with the results he will obtain, and I certainly advise him to give it a trial.

IN PASSING—(concluded from page 376.)

At this point, Ambo, luckless fellow, fairly burst and had to pretend it was a sneeze. Meanwhile the old boy kept the pan in front of his face and stood mum till the lady had gone. Then he annoyed us by remarking coolly: "Bring a barber, Julian, and let me get rid of this beard. It's the chance of a lifetime. My wife made me grow it in 1877 because I used to swear when I shaved. It's been the curse of my existence. Go on! Hurry!"

Turning to me, he said, "Young man, I want the best safety-razor on the market and I want to play with a three-valve set. Julian will pay for the set."

China Again

I tumbled. I was being fined. Kismet! After the barber had cleared up the mess, pa-in-law emerged from the fernery, feeling his chin and clucking feebly.

"Why, pa," said Ambo, "you look fifty years younger. B-but what'll Mary say? Gee whizz!"

"That's what I'm skeered of," replied the ancient, sitting down heavily. "I almost wish I could put it all back."

"Ambo," I said, "the answer is simply this. *Asia.*"

So he pressed his finger on Hong Kong, and there was "the open door of China" gaping. China appeared to be inhabited by bottles.

More Surprises

The old man whistled. "So *that's* where you—— (*Sadly*) I often searched, too."

"That's enough, pa," said Ambo shortly. "Keep it dark! Say when!"

On our return from China we went downstairs in a body to break the news. More surprises.

Mary said: "Thank goodness, father," and to me, "I think my menfolk are all the better for your acquaintance. Can I offer you something to drink?"

Ambo exploded again.

"You'd better take something for that cold, Julian," she said. "*Tincture of quinine, I mean.*"

This set old Twipe off into a hysterical cackle and he had to be thumped on the back.

"I think this wireless is excellent," he said on recovering. "It's done me a world of good already. Was that Wei-hai-wei or Canton you poked, Julian? Ha, ha! Ho, ho, ho! Tee, hee, hee!" *etc., etc., ad lib.*

Ambo grinned at me as he let me out. "It's all right. I'm going to swap the goods over. When the old boy goes to Asia next he'll find only my cheroots, which he can't smoke. He doesn't know the secret of the button underneath the wave-length chart."

THE "OVERSEAS" THREE

—concluded from page 386.

the H.F. valve again lights, tune once more so that the local station is at its loudest, when it will be found that the set is perfectly stable over all adjustments, the reaction condenser C requiring to be advanced before the set can be made to oscillate.

Turning the condensers C_2 and C_4 together, the signals from the local station will quickly become inaudible, and by slowly rotating these two condensers at their correct relative speeds, as indicated by a faint breathing sound in the telephones, a number of distant stations will be heard, perhaps at weak strength, but they will nevertheless be audible. After tuning in one of these stations, advance the reaction condenser from its zero reading, when it will soon be noticed that signals have increased in volume; increasing the reaction condenser too much will, however, cause the receiver to oscillate.

When one of these distant stations has been successfully tuned in, remove the aerial connection, and try connecting it to the other terminal, noting whether or not there is any increase in signal strength, not forgetting to retune with the C_2 condenser if necessary.

When using the terminal A the .0003 condenser C_1 is in circuit, whereas using A_1 connects the aerial directly to the coil L_1.

It will usually be experienced that when receiving those stations working upon wave-lengths above 400 metres, better results are obtained when using terminal A_1. On the other hand, including the C_1 condenser in circuit by using terminal A, stations working on wave-lengths below 400 metres will generally be more satisfactory.

In any case the use of terminal A will result in greater selectivity being obtained, though in some cases slight loss in signal strength may be experienced.

Results Obtained

When a station has been tuned in at relatively weak strength, the reaction condenser may be increased in its dial reading, so that the signals increase in volume, until a point is reached where a slight rushing sound becomes audible. This sound is indicative of the fact that the set is adjusted too near the point of oscillation, and if the condenser is turned further, distortion will be the reward.

After some little practice with the set it will be found a simple matter to keep the receiver just off the oscillation point, and so in its most sensitive condition, throughout the whole tuning range, and once this skill has been achieved the finding and successful tuning in of the distant station will seem like so much child's play.

As explained in the early part of the article, the receiver has been used for some time in south-east London, and during the transmission of the local station most of the British and continental stations have been received: Birmingham,* Newcastle,* Bournemouth, Glasgow, Radio Belgique,* Copenhagen,* Oslo,* Hamburg,* Radio-Milan, Frankfurt, Munster and Stuttgart* are those most successfully received. Other identified stations which are received are Radio Toulouse, Radio Barcelona, Leipzig*, Radio Wien and Rome. A number of others have been picked up but though these have been heard on many occasions never have they been enterprising enough to announce their name.

*Those stations marked with asterisks denote reception on the loud-speaker.

SETS OF COMPONENT PARTS

RADIANO "THREE" (*March, '27, Wireless Constructor*). All parts as specified with Terminals. 2 Ormond S.L. Variables, with friction gear, 29/6; 3 Coil Sockets, 5/3; T.C.C. ·0003 and Clips and 2-meg. Leak, 5/10; 3 Benjamin Valve Holders, 8/3; 3 Fixed Resistors and Bases, 7/6; On and Off Switch, 1/6; Gecophone 1st Stage L.F., 24/-; Brandes 2nd Stage L.F., 17/6; Engraved Strip, with Terminals and Nuts, 3/6; 2 B.L. Terminals for Front Panel, 1/6; ½ Gross Pinch-on Spades, 1/-; Quantity Rubber Flex, 6d. Total, £5 5 10. Post free for £4 12 6 nett.

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LODGE "N" CIRCUIT. 1 var. condenser, ·00005 (3 plate), 4/11, with knob and dial. 1 special Silvertown L.F., 21/- (essential); 9 terminals, 1/-; 2 single coil stands, 1/- each; 2-valve holder, 2/3 each; 1 rheostat, 2/-; fixed, ·0001, 1/3; 1 variable gd. leak, 2/6. Wire, screws, transfers, plugs, terminal strip. The lot, post free, 32/6 net.

MONODIAL RECEIVER. Original components. ("Wireless") 4 A.P.V. Holders, 10/-; R.I. Multi L.F., 25/-; Pacent Super L.F., 24/6; H.F. Varley Choke, 9/6; Varley 250,000 ohm Resistance, 9/6; On and Off Switch, 1/6; 2 Jacks, 6/-; 4 Fixed Resistors, 10/-; B.B. Neutralising, 10/-; 1 Franco Midget, 3/9; 2 ·002 Fixed, 4/-; 2 H.F. Transformers, with 6-pin base ready for use, 21/-; and TWIN GANG ORMOND CONDENSER, 32/-. Total List, £8 4 9. Sent post free, £7 7s. Slow motion dial, 5/- extra.

RODNEY (P.M.) 12 Terminals, 1/6; 3 A.M. Valve Holders, 6/9; 2 Single Coil Stands, 2/-; 2 Variable Condensers, ·0005, 15/-; 2 S.M. Dials, 12/-; 1 ·0003 Sq. Law, with Knob and Dial, 5/-; Neutralizing Condenser, 3/6; Rodney Magnetic Reaction H.F. Transformer, 9/6; 6-pin base, 1/6; (B.B.C.) ·0003 and 2-meg., 5/-; Fil. Rheos, 2/-; R.I. Choke, 9/-; 100,000 ohms, Fixed, 2/6; L.F. Transformer, Ferranti, 25/-; Fil. Switch P.P., 1/6; Centre-tapped Tuning Coils, 2 Aerial Coils. Post free, 89/6 nett. List Price, 109/6.

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EDISWAN R.C. THREESOME. Set of Parts: 2 Ediswan R.C. units, 7/- each; 1 Ediswan P.V.2 Valve, 18/6; 2 Ediswan R.C.2 ditto, 14/-; 3 Lotus V.H. at 2/6; 3 Fil. Rheostats at 2/6; 9-v. Grid Bias, 2/-; Lotus 2-way L.H., 7/-; ·0005 Tuning Condenser, 6/11. The lot, post free, £3 19 6. (List price, 91/5. With cheaper (but good) rheostats, valve-holder and 2-way, 69/6.

T.C.C. MANSBRIDGE. ·0003 S.P., ·00025 S.P., ·01, ·02, 2/4 each; ·1, 2/6; ·25, ·3, 3/- each; ·5, 3/4; 1 mfd, 3/10; 2 mfd., 4/8.

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CABINETS. — American type, solid, polished hinged lid and baseboard. 8 in. x 6 in. x 7 in. deep, 6/11; 10 in. x 8 in. x 8 in., 8/11; 12 in. x 8 in. x 8 in. 10/6 and 12/8; 14 in. x 7 in., 13/6; 16 in. x 8 in., 16/11. Any size made to order in a few days.

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GEARED COIL STANDS. 2-way, 2/3, 2/6, 2/11 up. 3-way, grand value, 5/11. Back of panel from 2/11. All ebonite and best quality. Only needs seeing. Fenton, Newey G.E.C., Lotus, Polar stocked.

AERIALS.—100 ft., 7/32 Hard drawn, 1/11. Extra heavy, 2/2. Phosphor 49 strands, 1/-. Electron stocked. Special INOOOR Aerials, phosphor, with ebonite separators and rubber rings (12 ft. x 8 strands), total 100 ft., 4/6. O.V., 2/6. Rubber Lead-in, highest quality, 10 yds., 1/-; 10 yds., 1/3; 10 yds., 1/6. Extra heavy, 2d. and 3d. yd. R. & B. Twin Flex (best), 6 yds., 10d.; 12 yds., 1/6; 36 yds., 4/-. Ins. Hooks, 2 for 1½d. Egg Insulators, 2 for 1½d. Ins. Staples, 4 a 1d., Earth Tubes, Copper, extra value, 2/3. Climax, 5/- (also at 2/6).

SWITCHES. — On porcelain DPDT, 1/3; SPDT, 10½d. Superior articles. Nickel, Panel, Ebonite handle. DPDT, 1/6; SPDT, 1/-. Push and Pull, 9½d and 1/- All Lissens stocked.

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PERMANENT DETECTORS.—Liberty, 3/6. Red Diamond (a topper), 2/-. Lion Micro, latest cannot be equalled, 2/6. Brownie, 3/-. Enclosed Kay Ray, 1/-, 1/3. Service Micrometer, with crystal, 2/9. Burndept 4/-, Mic Met, 4/6.

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THE "BLACK PRINCE"

—concluded from page 348.

condensers so that the point of setting on the neutralising condenser, where this happens, is half-way down its travel.

Results obtained

The receiver is very selective, and for four valves extremely sensitive. The number of stations you will receive on the loud speaker will depend upon the conditions at the time when you listen, but with the multiplicity of stations now working in Europe, it is possible on a good average night, with a reasonable aerial, to get some fifteen or twenty stations on the loud speaker, the strength of reproduction varying between quiet and full loud speaker strength. At least half a dozen stations should always be obtainable at full loud-speaker strength without it being necessary to push reaction amplification up to the point where serious distortion occurs. A list of dial readings of stations received in one evening on this set is given in the table attached to this article.

Bearing in mind that conditions vary from night to night, it can be stated that this list is representative of an average evening.

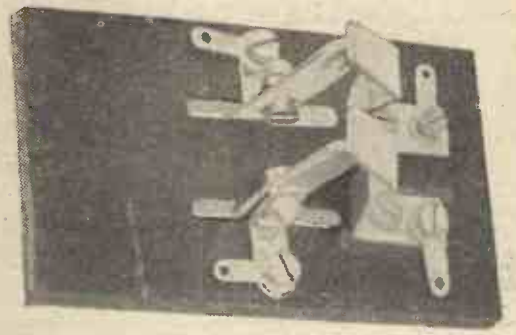
A SIMPLE LEVER SWITCH

—concluded from page 420.

is placed in the H.T. positive lead of the receiver, these holes will have to be tapped out, since a bolt right through from one side to the other would short-circuit the H.T. battery. reception it is only necessary to remove the two short-wave coils and substitute for them the long wave. No readjustment of the neutralising condenser is necessary.

Fixing the Crossbar

It is possible to get over this difficulty by placing the H.T. switch in the negative lead. There are then two ways of connecting it up, as shown in Fig. 3. If L.T. negative is to be joined to H.T. negative, the L.T. negative can be connected to both of the arms, L.T. positive to one of the contacts and H.T. negative to the other. If, on the other hand, L.T. positive is to go to H.T. negative, then the former lead must go to the two arms, L.T. negative being connected to one of the arms. In either of these two cases the arms are common to one connection. The simplest way of fixing the crossbar is therefore to make it of ebonite tube and pass a 6 B.A. bolt right through it, securing it with a nut on the other side.



The photograph shows the appearance of the spring contacts at the back of the panel. Note how the soldering tags for conections are arranged.

SIR OLIVER LODGE'S NEW BOOK

Reviewed by
Dr. J. H. T. ROBERTS., F. Inst. P.

["Modern Scientific Ideas." (Being the expanded substance of six talks on "Atoms and Worlds" broadcast in October and November, 1926) by Sir Oliver Lodge (Ernest Benn, 6d. 79 pp.).]

THIS fascinating little book is dedicated by the Author "with friendly greeting, to all, of any age, in whom an interest in physical science is awakening, especially to those who listened to his radio talks on atoms and worlds."

Sir Oliver Lodge, by general consent, occupies an unique position amongst scientific thinkers, not only by reason of his vast knowledge of natural and moral philosophy, but for his extraordinary gift of eloquent and popular exposition. Probably it could not be said of any other scientist, of any period, that his name became, during his own lifetime, a household word in the way in which Sir Oliver Lodge's name has become. And this is principally due to that remarkable faculty for taking the most abstruse scientific and philosophic conceptions, and, by clear insight and by the use of simple and beautiful language, rendering them into a form appealing to all.

"Uniformity of Nature"

Those who were privileged to hear his recent broadcast talks on "Atoms and Worlds" will welcome the present little volume which, as stated in the sub-title, is a record of those discourses. On first reading the book I confess to a little disappointment. It is the same kind of disappointment which one feels after reading Shakespeare on seeing him acted; or, rather, it is the reverse kind. I have listened to every one of Sir Oliver's talks over the microphone, and on reading his book I found myself trying unconsciously to *read* as I had heard him *speak*.

Not that the book is not in itself an absorbing elucidation of the wonders of scientific discovery, but Sir Oliver has that "something" in the voice and the delivery—as all who have heard him will agree—which gives an impressiveness to his utterances that perhaps can never quite be conveyed in print.

One of the bases of scientific deduction is the theory—or the thesis—that what we call the "Laws of Nature" are unaffected by the activity of life or mind, and that they are independent of Time, in the sense that they do not vary from one point of time to another. This is sometimes referred to as the "Uniformity of Nature," which, as the Author says, "is a postulate or axiom based on experience, mainly unconscious and unformulated experience, as all our axioms are." A practical consequence of the acceptance of such a thesis is the belief that a given set of physical conditions will produce a given result, whether the occurrence takes place to-day, or to-morrow, or a year hence, and that any variation in the result must indicate a variation in the physical conditions and cannot be brought about purely by the difference in point of time.

Power of Prediction

The basis of Materialistic Philosophy is the theory that the actions of life and mind are intimately and inevitably related to the operation of what we call physical laws, and that, therefore, the whole of the future is determined at this present moment by the inexorable working out of the laws of the physical universe.

On the other hand, those who cannot accept materialistic philosophy believe—or, rather, *feel*—that there is something in the universe of a different order—something not calculable by any of the rules of physical science; that the power of prediction is limited not only by our capacity but by the nature of things themselves, and that the uniformity of physical nature can, in fact, be interfered with by the real agency of self-determination and free-will.

The astronomer can calculate the orbit of a planet, a comet, or even a meteor; the physicist can deal with the structure of atoms; the chemist with chemical combination; but neither the biologist nor any scientific man can hope to calculate the orbit of a common fly!

Continuity and Evolution

Having dealt with the fundamental notion of Uniformity, the Author similarly deals with the other two fundamental notions of Continuity and Evolution, and goes on to show that what we call Time may be a human illusion.

Of the three fundamental physical quantities—mass, time and space—Time, although the most accurately measurable, is perhaps the most elusive and difficult to comprehend. It may be that Time is an illusion, in the sense that its apparent existence is due to the limitation of human faculty, and that, were our faculties sufficiently developed, we could not only perceive the whole of the present as an instant, but could include the past and the future in a comprehensive survey, and see the whole of existence as an Eternal Now.

A Miniature Solar System

Everyone knows that matter is composed of molecules and molecules of atoms. This view, which has been held by chemists for very many years, prevails now with important expansions and elaborations. For whereas, until a few years ago, the atom was regarded as the ultimate and indivisible particle of matter, it is now known, with a considerable degree of certainty, that the atom is itself a miniature solar system, and that the particles or units of the atomic solar system are electrical particles (disembodied electrical charges or corpuscles, as they are sometimes called), some of which pursue well-defined orbits in the same way that the planets in the Heavens pursue their orbits around the sun.

The flying or planetary electrical particles are known as electrons and each carries (or consists of) a charge of negative electricity, whilst the centre or nucleus of the atom—corresponding to the sun in our planetary system—comprises a further number of negative particles of electricity or electrons, together with a number of positive electrical particles known as protons.

The chemical properties and characteristics of the atom depend upon the number and arrangement of these flying or planetary electrons, whilst certain of the physical characteristics of the atom are associated with the constitution of the nucleus.

These advances in knowledge are due to the labours of many scientists, towards the end of the nineteenth and the beginning of the twentieth century and particularly to the genius of James Clerk Maxwell and J. J. Thomson.

"If an atom were magnified to the size of a cathedral, each component electron would be something like the size of a gnat. Twenty or thirty gnats in a cathedral would not occupy much space. Now imagine the gnats without the cathedral; let them fly round and round within its quondam

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SIR OLIVER LODGE'S NEW BOOK

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walls and you have a model of the scientist's conception of an atom of matter, except that the regulated system of law and order, and many other important and essential properties, are absent from the model; the model exhibits only the relative size and fewness of the particles as compared with the space they occupy."

Manifestation of Law and Order

Two hundred and fifty million atoms in contact with one another in a row would stretch about an inch, and a hundred thousand electrons similarly in a row would stretch about the diameter of a single atom. And yet in spite of the almost incredible minuteness of the electron it seems that there are other particles even smaller still..

The author continually reminds us —not pointedly, but perhaps inevitably—of the abundant evidence on every hand of the presence of an all-controlling and all-designing Mind. "There is no chance, nothing haphazard in any part of the universe. It is a manifestation of law and order and beauty which appeals to our higher faculties; and in moments when we realise even one aspect of that revelation overwhelms us with wonder, love and praise."

This little book will fill not one but many absorbing hours, and the reader is left with a sense of loss that its short pages have so soon drawn to a close.

A Correction

On page 309 of the March issue of MODERN WIRELESS an advertisement concerning Ferranti transformers appeared. The very top line of this read "Single Radio Transformers," but the word radio should have been "ratio." Probably many readers immediately noticed this misprint, although others might have found that the error caused them to mix up the whole sense of the advertisement. In fact, it is worth while turning back to it and noting how seriously one word can affect the whole sense of a statement.

THE "FOUR-COIL TWO"

—concluded from page 373.

tion can be made of the following for V_1: Cossor Point One (Red Band) 210H or 410H, Mullard PM1 H.F. or PM3, Burndept H.310 or HL 310, Marconi DE2 H.F. or DE3 B., etc.; while for V_2: Marconi DE2 L.F. or DE8 L.F., Cossor Stentor Two or Stentor Four, Mullard PM1 L.F. or PM4, Ediswan PV2 or PV4, etc. The position of the moving contact on the baseboard resistor can be estimated for the desired voltage.

Coming now to the coils, the exact turn numbers will vary in particular cases, but two arrangements that gave quite good results on test were L_1 —25, L_2 —40, L_3 —50 and L_4 —35; and L_1 —40, L_2 —20, L_3 —75 and L_4 —60. The value for C_1 can be adjusted as desired, ·0002 being a fair average capacity. Set the reaction condenser C_4 at zero and, having joined up aerial, earth, and telephones to the appropriate terminals, tune in the local station on C_2.

The Long Wave Coils

The adjustments of the balance in the amount of coupling between L_1 and L_3 and the capacity values of C_1 and C_2 now follow, and many possible trials can be effected. Always reduce the amount of reaction on C_4 when making these trials.

When tested on an aerial of average size and efficiency about ten miles north-west of London, that station came in at full loud speaker strength, the purity of the reproduction being particularly good. Several other stations were heard at varying strengths on the telephone and loud speaker, the expectations of selectivity being justified by the results obtained.

The long-wave stations can also be received, and here again exact coil values will depend upon local conditions. One arrangement which I found to be suitable in my own case was L_1 —200, L_2 —150, L_3 —150, and L_4 —100. The effect of C_1 also must be given due consideration. The Daventry station was heard at very good loud speaker strength at the situation previously mentioned.

It is thus seen that, as a local receiver, this set fulfils the requirements admirably, providing, in addition, ample scope for experimenting with various aerial coupling combinations.

A CHAT ABOUT RESISTANCE

—concluded from page 392.

circuit when the second circuit is brought into resonance.

Here, then, is one of the fundamentals governing the importance of due regard being given to the lay-out of a wireless set, so that stray couplings may be reduced or, if possible, eliminated, so as not to produce inefficient working. Thus coils which must not interact with one another should be kept as far apart as space will allow, with their planes at right-angles and, of course, the wiring executed with meticulous care.

Losses in Coil Screens

Following on this there is the influence of magnetic material situated close enough to a circuit to be magnetised by it. When the lines of force of the magnetic field produced by a coil reach any magnetic material, they produce what are known as eddy currents in that material. If the field changes due to any alteration of current flow through the coil, the eddy currents will change accordingly, but they are always in such a direction as to reduce the field of the magnetising coil.

Now, in a similar manner to the previous case discussed, viz. neighbouring circuits, the production of these currents represents a loss in the coil, since the necessary power has to be supplied by the coil; and this evidences itself as an increase in resistance which may prove very serious, especially at high frequencies. The point immediately arises, then, as to whether the metallic shielding which is becoming fairly popular in wireless receivers at the present time justifies its inclusion. The purpose of the shield is, obviously, to prevent any stray coupling between the various parts of the circuit which, for efficient working, should be more or less isolated.

The Type of Shielding

The type of shielding is important, however, for it is naturally beneficial to keep the resistance as low as possible, and in cases where a particular component is completely shielded, the surrounding screen must be of a certain minimum diameter or the resistance may show a large percentage increase. It is for this reason that some designers prefer to use a meshed metallic screen, for it can then be placed somewhat farther from the coil or coils by resorting to the screening of a complete stage.

This will reduce the number of turns of force intercepted, and thus the eddy currents will not assume such large values, with the natural sequence that the coil resistance is not increased unduly. Employing reasoning of this character for each case as it arises will enable the constructors to weigh in the balance the points at issue, and permit of a correct solution being found.

Turning for a moment to the consideration of condensers which may be present in a circuit whose resistance must be kept low, it should be borne in mind that any losses which occur will naturally evidence themselves as a resistance. These losses can be grouped together and represented by a hypothetical resistance for calculation purposes, the value of the resistance depending, amongst other things, upon the frequency of the circuit.

Thus, as indicated in Fig. 8 (A and B), the condenser with an imperfect dielectric can be looked upon as a perfect condenser with a small series resistance, or a large shunt resistance together with a perfect condenser. To deal with all the salient features in condensers, with the allied subject of losses, would require an article on its own, so here it will be sufficient to indicate briefly the important points to notice in order to reduce the losses.

Condenser Connections

With variable condensers the connection from the moving plates is perferably in the form of a helical spring or insulated pigtail, and quite sound electrically, while the amount of solid dielectric in the condenser field must be reduced to a minimum and be of good quality. The plates should be constructed from a metal not oxidisable readily, e.g. copper, and where possible the condenser can, with advantage, be completely enclosed to prevent any troubles arising from the presence of dust or particles of dirt. With fixed condensers the external moulding must be of good quality, with a sound dielectric.

Viewed as a whole, then, it will be at once apparent that the problem of resistance is a very far-reaching one, and has an important bearing on the successful operation of wireless sets. A little study devoted to the features involved will be more than repaid in the better understanding of its advantages and disadvantages, and the application of that knowledge to the improvement of wireless reception.

RADIO ABROAD

—concluded from page 412.

organist who regularly gives recitals "on the air," has found that he gets a very much better effect if he wears a pair of head-telephones whilst playing the organ, these 'phones being connected to the broadcasting microphone circuit in such a way that he hears the music exactly as it goes out to the listeners. In the ordinary way, when he listens to his own playing direct by ear, he is apt to get quite a wrong impression, for the Console is at a distance of about 35 feet from the more remote parts of the organ. Another important factor is that some of the notes which sound loudest when listened to directly by ear "come out" of inferior strength when broadcast, owing to peculiarities in the pick-up of the microphone and in the amplification by means of the transmitting apparatus. By using the head-telephones in the way just mentioned above, he puts himself in the position of a listener at a broadcast receiver, and he has found from experience that, when broadcasting, he has to play in an entirely different manner, accentuating certain parts in playing for the purpose of bringing them up to normal strength when received.

S.B.

In a recent talk to members of the New York Advertising Club, Mr. George McClelland, the general manager of the International Broadcasting Company, stated that they were now able to connect up 35 broadcasting stations simultaneously, thus enabling fifteen million persons to listen at once to the voice of a single individual. He stated that there were approximately 671 active broadcast stations in the United States and 950 broadcasting stations throughout the world.

Mr. McClelland made some interesting observations on the changes which had taken place in the public taste in the matter of broadcasting. Three or four years ago, he said, the demand for jazz was nearly 75 per cent., whereas to-day it represented a preference of only about 5 per cent.

Other interesting figures related to the number of persons employed directly or indirectly in the radio industry in the States, this number being placed, according to Government estimates, at 300,000. The yearly sales of radio sets and parts amounted to about two million dollars. In 1926 this amount had increased to 500 million dollars, while the estimated sales for 1927 are 535 million dollars. The gross sales credited to the radio industry for 1920 to 1926 inclusive are about 1,500 million dollars.

Amateur Transmission

Some very interesting results in amateur rebroadcasting are reported from station W A A M in Newark, New Jersey, where Paul Godley, a well-known radio engineer, receives various distant stations every Friday night on his 6-valve set, and re-transmits for the benefit of local listeners. The rebroadcasting continues so long as the reception is sufficiently good, and by this means many W A A M listeners have reported that they have been enabled to hear Pacific Coast stations for the first time. Two sets have been installed at Cedar Grove, in an isolated section of the State, where reception is known to be particularly good. The 6-valve set used for reception, prior to the rebroadcasting, has two stages of high-frequency and three stages of low-frequency. A loud speaker is placed directly before the W A A M microphone, and the signals are conveyed by wire to the sending station in Newark.

Whilst the broadcasting is going on, Mr. Godley uses another set—this time a 7-valve outfit—with which he searches for other distant stations so that there is never any considerable gap in the sending. The aerial used is 35 feet high and 150 feet long.

D.X. Parties

This rebroadcasting arrangement is now known as a "D.X. party," and has created great interest amongst local experimenters. In many cases telephone calls, telegrams and letters are received by the amateur broadcaster, stating how the reception has been obtained, and frequently telephone calls are received asking for the dial settings on the broadcast reception set. These dial settings are announced over the air, and often further messages are then received stating that by following the instructions so given, listeners have been able to tune in direct to stations on the Pacific Coast. Recently San Francisco was received on the Cedar Grove set and rebroadcast from Newark.

Design of Small Power Transformers

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we find that the number of turns required on the primary works out at very roughly 1,600. In order to allow for defects in assembly and various other factors, it is always a good plan to increase the number of turns somewhat, and the number in this case should be put at about 2,000.

A point which should be particularly borne in mind is that the *effective* cross-sectional area of magnetic material of the core is usually much less than the experimenter may suppose. For example, supposing the interior of the spool be packed with iron wire—as is often done—the effective cross-sectional area of iron is the sum of the areas of the individual wires—as a matter of fact, it is actually decidedly less even than this—and you will readily see that, owing to the spaces between the wires, the sum of the cross-sections areas of the individual iron wires is much less than the cross-sectional area of the space into which the iron wires are packed.

Cause of Heating

It will be noticed from the above formula that the number of turns required on the primary is inversely proportional to the cross-sectional area of the core, to the flux density which the transformer iron will carry, and to the periodicity, whilst it is directly proportional to the voltage of the mains to which the primary is to be connected.

If the cross-sectional area of the core is actually less than the value assumed in the formula, or the material is of inferior magnetic quality to that assumed, the formula will give a number of turns for the primary winding which is lower than it ought to be, and consequently, when the transformer is running idle—that is, when the primary is connected to the mains but the secondary is on open circuit—the primary will consume a quantity of electrical energy which is more than an insignificant amount, and, also, the transformer will tend to become heated. The deficiency in the iron core may be compensated by an extra number of windings, but there are limits to the extent to which it is advisable to make up for a deficient magnetic core by this means.

If the transformer is well designed

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Design of Small Power Transformers

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—in accordance with the instructions set out above—the number of turns for the secondary winding may be calculated by the very simple rule that the voltage in the secondary will bear the same relation to the voltage in the primary as the number of turns in the secondary bears to the number of turns in the primary.

Gauge of Wire

The only remaining important point is the question of the gauge of wire to be employed. This depends entirely upon the current which is to be carried, although an unduly generous gauge should not be used as this tends to increase the bulk—as well as the cost—of the instrument. Where the primary is carrying a current of 1 ampere a gauge of about No. 20 would be suitable, and a gauge of 26 to 30 would be alright for ½ ampere. If the transformer is intended to be a "step-up"—for example, to be used with an eliminator for H.T. supply—and the current to be drawn from the secondary is very small, the gauge of secondary wire may be correspondingly small. Again, if the transformer is to be used only intermittently—as in a bell-ringing transformer—the gauge of wire may be less than that stipulated for steady current, and the wire may temporarily, or for short periods, be heavily overloaded, without much detriment.

"Running Idle"

When a well-designed transformer is running idle, the induced voltage of the primary is substantially equal to the voltage applied to it, and consequently the primary consumes practically no energy from the mains; this is sometimes expressed by saying that it draws a "wattless" current. As soon, however, as a load is imposed upon the secondary, and energy is being drawn from the transformer, the balance in the primary is upset and the primary at once begins to draw energy from the mains. In this way it will be seen that a well-designed transformer is a most efficient and convenient instrument.

RADIO NOTES AND NEWS OF THE MONTH

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Warsaw Calling

Have you heard Warsaw? One London reader tells me that he picked up the new Polish station at fair strength, upon a straight Det. and L.F.

This station—which was built by the Marconi Co.—is designed upon the lines of 5 XX, though less power is used. The wave-length is 1015 metres, so the tuning adjustment is just below that for Hilversum.

New Radio Physics

Most people use bismuth as a sort of "settler"—but not Dr. H. Palmer Craig, who is head of the Department of Physics at the Mercer University. Dr. Craig has recently unsettled all the valve-makers in the U.S.A. and kept them awake at night, poor chaps, by announcing the invention of a new detecting and amplifying gadget. Reported to be made of bismuth and sulphur, it renders radio valves and their batteries totally unnecessary.

Full details of the invention are not available at the moment, but they are being awaited with intense interest.

A Long-Wave Shuffle

The recent International conference at Brussels did quite a lot of hard thinking about long-wave broadcasting, and as a result there will soon be some excitement above the 600 metre line. Several new high-power stations are shortly due on the ether, and the International Bureau is taking timely steps to prevent long-wave interference. So the aristocrats of the long waves—5 XX, Radio-Paris, Hilversum, and Co.—are working overtime, with the praiseworthy idea of finding the best wave-length position for each long-wave station in Europe.

New Daventry Station

In British broadcasting circles, "Daventry Junior" continues to be the topic of the moment. Like Brer Rabbit, the B.B.C. lay low and say nuffin', but it is possible to fix the opening date of this new experimental station for round about the middle of September. It might be much sooner—or later—but listeners will be able to guess for themselves when the test transmissions are in full swing, for the fate of the scheme will depend upon the success of the Daventry tests upon the 300-600-metre band of wavelengths.

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RADIO NOTES AND NEWS OF THE MONTH

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The "Sky-Scraper"

The Editor's attention has been drawn to the fact that the coil used in "The Sky-Scraper" (described in MODERN WIRELESS last February) bears a very strong family resemblance to one described previously in "The Wireless World." In fact, it looks uncommonly like the same coil!

This apparent plagiarism was entirely accidental, and undoubtedly our contemporary can claim prior publication.

The "Combine" Five

As was only to be expected, tremendous interest has been aroused by the "Combine" Five, details of which were published in MODERN WIRELESS last month. Many correspondents appear to have been rather puzzled by the modifications to the circuit suggested by one of our advertisers. To clear up any misconception that may have arisen in this connection, it may be as well to state that the designers of The "Combine" Five see no reason why the set should not work splendidly if the recommendations referred to are carried out. On the other hand, they cannot accept any responsibility if departures are made from the circuit as shown in The "Combine" Five Book, for it was in this form, exactly as published, that the original "Combine" Five proved such an outstanding success.

Can't Do Without It

Owing to a regrettable shortage of shekels, Johannesburg, one of South Africa's most important broadcasting stations, recently had to close down completely. Appeals to the Government for support were apparently disregarded, but at the time of writing it appears that a society of private individuals had voluntarily restarted a broadcasting service. Further outlook—unsettled.

Hang the Microphone!

That is what they are doing at Savoy Hill now. Instead of standing the microphone upon a rubber pad supported by four spreading legs, it is now suspended about nine feet from the floor.

If only they could treat some of the performers in the same way!

IN OUR TEST ROOM

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pots. In some way these have an advantage over sac units, although their internal resistances will be greater and their current capacities somewhat smaller as depolarisation will be less efficient. However, the cells are larger than the usual wet H.T battery cells and they should be capable of very useful work. Wet H.T. batteries of this type are worthy of serious consideration, for they have advantages over the dry battery which are obvious. We have had wet H.T's of this nature in use for considerable periods, and they have given satisfactory results.

M.H. H.F. Choke

There seems to be a pleasing tendency these days to combine efficiency with adaptability in radio components. The new M.H. H.F. Choke is an outstanding example of this. It has an inductance of 60,000 microhenries and a very low self-capacity. Its ohmic resistance, too, is of a low order. A slotted barrel former with coned ends is employed. With regard to adaptability the component can be mounted on either the baseboard or panel in the usual way, or held between clips similarly to an anode resistance.

On test we found this McMichael product to be efficient over a very wide band of wave-length.

It is very well made and should prove one of the most popular components of a popular line at the reasonable price of 9s.

An Efficient Crystal Detector

Messrs. N. M. C. Detectors, of 30, Princes Parade, Finchley, N.3, recently sent us an N.M.C. detector to test. This detector makes use of iron pyrites, a very efficient radio mineral when obtainable in suitable condition for the purpose. And judging by that accompanying the detector sent us we should imagine that the N.M.C. people have access to a very valuable source of supply. The crystal can be used with a very firm contact, so firm in fact that the N.M.C. detector is designed on more or less "permanent" lines and very seldom indeed needs adjustment. It is most stable and can be mounted beneath the panel of a crystal-valve set without fear that it will call for frequent attention. Despite its stability, it is sensitive. The price of the detector is 1s., and it is guaranteed for five years.

A "Self-Soldering" Wire

Following the arrival of an ample supply of the material, we have been using "Junit" for some little time to wire up various sets and find it very pleasing to use. "Junit" is made by the Rexo Engineering Co., of 2, Ravenscourt Square, London, W.6, and is rather unique in character. It is square in section, but is grooved, and in its grooves it carries a supply of solder. Thus a touch of flux and a hot iron and the job almost completes itself, more especially when "Junit" is joined to "Junit." But what we particularly like about this material, quite apart from the fact that it enables neat, efficient soldering to be carried out easily and expeditiously, is its remarkable toughness and pliability. It can be bent, unbent, and bent again without breaking, and it makes it a simple task to obtain bends and angles just where one wants them. "Junit" is quite cheap, and should prove a very popular wire among home constructors.

A Coil Screen and Base

Messrs. W. Wilkinson & Co., Excelsior Electrical Works, Halifax, recently sent us a sample coil screen and base. They conform with the desired standards and are well made and nicely finished. We particularly like the manner in which the base is clearly marked, this will assist greatly in connecting it up, and should prevent mistakes occurring. The screen fits closely, but can easily be slipped on and off. The complete arrangement retails at 8s. 6d.

Lamplugh Potentiometer

We recently received a potentiometer from Messrs. S. A. Lamplugh, Ltd., King's Road, Tysley, Birmingham. It has a resistance of 500 ohms, which is a sensible sort of value for even when connected across a 6-volt L.T. it would pass but 12 milliamps. which would be but a tiny drain upon an accumulator. And the wire with which its resistance element is wound is of a very substantial gauge, too, and should enable the component to stand up to hard usage more or less indefinitely, especially as the contact is a smooth, easy one. This Lamplugh Potentiometer is well made in all other respects, and is provided with substantial terminals and soldering tags and a large dial and milled adjusting knob.

Index to Advertisers

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